CRAYFISH DISTRIBUTION AND SPECIES COMPOSITION IN MUSKOKA AND HALIBURTON LAKES

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ABSTRACT

In 1988, the Biological Studies Unit of the Limnology Section initiated a monitoring programme to assess long-term trends in the composition of benthic invertebrate communities in acid-stressed soft water lakes. One of the objectives of this programme is to determine the occurrence of crayfish species, especially Orconectids, in these lakes in relation to lake chemistry particularly lake pH. This data report summarizes the biological and chemical data collected for the 12 study lakes. A detailed description of the methods of crayfish collection is also included.

SOMMAIRE

En 1988, l'Unité des études biologiques dans la Section de limnologie a commencé un programme de surveillance pour évaluer les tendances à longue échéance dans la composition de la population des invertébrés benthiques dans les lacs à eau douce qui sont affectés par les pluies acides. Ce programme a pour un de ses objectifs la détermination de la présence de l'espèce d'écrevisse, en particulier l'Orconectide, dans ces lacs en corrélation avec la chimie aquatique, surtout le pH du lac. Le présent rapport résume les données biologiques et chimiques recueillies pour les 12 lacs sous étude. On a inclu aussi une description détaillée des méthodes de collecte utilisées pour l'écrevisse.

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INTRODUCTION

A monitoring program was initiated in 1988 by the Biological Studies Unit to assess the affects on benthic organisms of changes in water chemistry due to acidic deposition. Crayfish have been reported to be extremely sensitive to low pH (Malley 1980; France 1987; Berrill et al. 1985) and consequently a subcomponent of the monitoring programme was designed to assess changes in crayfish populations over time. This subcomponent was initiated with a trapping study which was designed to assess the proposed monitoring techniques and to provide an initial description of the species composition and relative abundance of the crayfish in the study lakes.

METHODS

Study Lakes

Six of the study lakes are located in the old Lake Algonquin basin, formed after the Wisconsin glaciation (Blue Chalk, Crosson, Hamer, Harp, Skidway, Young). The other six are in the Algonquin-Haliburton Highlands (> 340 m above sea level) (Clear, Cradle, Delano, Pincher, Plastic, Westward) (Figure 1). All of the lakes are small headwater lakes (18 to 106 ha) (Appendix 2), and all of the study lakes are located on the Precambrian Shield area of south-central Ontario where sulphate deposition is high (0.75-1.25 g m^{-2} yr^{-1}) (Neary, Dillon 1988).

Site Selection

A preliminary survey of the shallow areas of the littoral zone of each lake was conducted to locate suitable sampling sites. These sites represented three major habitat types characteristic of lakes in the region (i.e. detritus,macrophyte, and rocky) (Appendix 1). A detailed description of substrate type for each site was compiled by the divers, who divided each site into three sections according to depth (i.e. 0-2, 2-4, and 4-6 metres) (Table 1).

Figure 1 : Location of the study area showing the twelve lakes

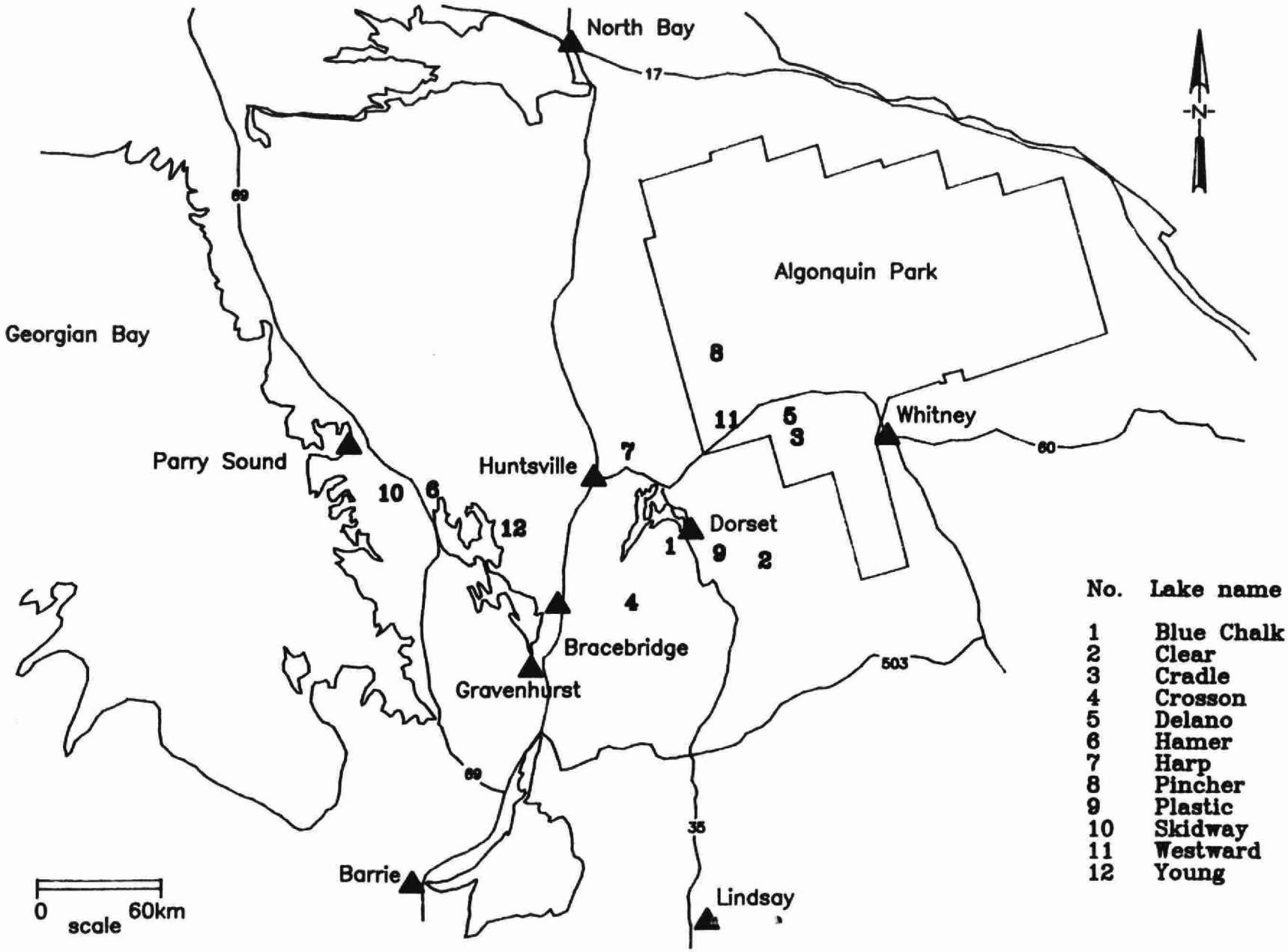

Table 1: Substrate types of site locations in the 12 study lakes.

	Site #1			Site #2			Site #3		
		Metres			Metres			Metres	
Lake	0-2	2-4	4-6	0-2	2-4	4-6	0-2	2-4	4-6
Blue Chalk		macrophytes[1]			rocky[1]			detritus[1]	
	macrophytes logs	sand mud leaves logs	sand mud	sticks rocks	rocks boulders	rocks	silt leaves sticks rocks	boulders logs sticks	rocks
Clear		macrophytes[1]			rocky[1]			detritus[1]	
	sand mud	sand mud	----	rocks	rocks	rocks	rocks mud	mud	mud
Cradle		rocky[1]			macrophytes[1]			detritus[1]	
	sand mud ledge	rocks	rocks	sand rocks	sand macrophytes rocks	rocks sand mud	ledge rocks	boulders	boulders
Crosson		rocky[1]			macrophytes[1]			detritus[1]	
	stones ledges	boulder pile	mud a few boulders stones	sticks rocks	scattered rocks	mud sand a few rocks	sticks leave litter small rocks	soft silt covered	----
Delano		macrophytes[1]			detritus[1]			rocky[1]	
	macrophytes	sandy mud	----	logs ledge	ledge sand rocks	mud	logs rocks	boulders rocks sand	sandy mud
Hamer		macrophytes[1]			rocky[1]			detritus[1]	
	rocks logs detritus mud	mud	deep mud	sticks detritus mud	mud	mud	ledge stones mud	mud	mud

[1] Substrate types assigned by the trapping crew.

Table 1: Substrate types of site locations in the 12 study lakes. (cont'd)

Lake	Site #1			Site #2			Site #3		
	0-2	Metres 2-4	4-6	0-2	Metres 2-4	4-6	0-2	Metres 2-4	4-6
Harp		macrophytes[1]			rocky[1]			detritus[1]	
	lily pads leaves sticks sand mud	sand mud	mud silt	rocks boulders	sand mud	----	logs sticks leaves rocks boulders	rocks boulders	rocks boulders
Pincher (no dive)[2]		detritus[1]			macrophytes[1]			rocky[1]	
		----			----			----	
Skidway		macrophytes[1]			rocky[1]			detritus[1]	
	sticks log detritus macrophytes	mud sand macrophytes	mud macrophytes	sand silt logs slime	mud sand macrophytes	mud macrophytes	macrophytes	sand macrophytes	mud macrophytes
Westward		macrophytes[1]			rocky[1]			detritus[1]	
	macrophytes scattered rocks on sand	scattered rocks sandy mud	sandy mud	sand logs boulders on sand	boulders	ledge boulders	sand macrophytes a few rocks	sand a few rocks	sandy mud
Young		rocky[1]			macrophytes[1]			detritus[1]	
	cobbles rocks covering sand	sand	rocks on sand	short macrophytes rocks on sand sand	rocks and boulders on sand	sandy mud	sticks detritus and logs	ledge (no rocks)	ledge few rocks

[1] Substrate types assigned by the trapping crew.
[2] Due to adverse weather conditions, flights were unavailable to the divers.

Detailed descriptions (0-2, 2-4, 4-6 m) compiled by divers.

Water Sample Collection

Water samples were taken for chemical analysis at each of the three trap sites. In addition, a mid-lake sample was collected. A composite sample (surface - 1 m) was taken at the trap site, and a composite sample (surface - 5 m) at the mid-lake locations.

Samples were collected with a peristaltic pump through tygon tubing. Composites were obtained by pumping the water into an 8 L polyethylene carboy, while the tubing was lowered to the desired depth and returned to the surface. The water was filtered through 400 μm mesh. Composite water was then poured into appropriate bottles for analysis[1] (Table 2).

Crayfish Survey

Crayfish were trapped in standard wire-mesh minnow traps with openings enlarged to 5 cm. Traps were baited with a small (2 cm x 5 cm) perforated plastic vial filled with fish flavoured canned cat food (Somers 1986). Traps were set in the late afternoon and retrieved early the following morning. The sequence in which the sites were set and pulled was randomized to prevent bias in the trapping period. Traps were marked with 2 L plastic bottles attached to a measured length of rope. At each of the three sites 10 trap lines were set perpendicular to the shore, with a trap set at 1 m depth intervals from 1 to 6 m. Each of the 10 trap lines were set 5 m apart.

Each of the 12 study lakes was surveyed one night during July or August, 1988.

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[1] Analysis group as outlined in the Handbook for Sample Submission, Dorset Research Centre.

Crayfish Measurements

For each trap the species, number of individuals of each species and the sex, dorsal carapace length and live wet-weight of each individual was measured and recorded. The sex of each individual was categorized into three main groups - sexually active males (form I), sexually inactive males (form II) and females. The dorsal carapace lengths measured with calipers is the distance from the tip of the acumen to the posterior margin of the cephalothorax (Figure 2). The live weight data was determined with a battery operated portable scales (Ohaus; Port-O-Gram). Weights were not recorded for crayfish missing chelae, or for any crayfish caught in Clear Lake (equipment malfunction). Weights and lengths were recorded for only 526, 299 and 507 crayfish in Blue Chalk, Cradle and Westward respectively.

Site Assessment by Divers

Two scuba divers dove each of the three sites in the 11 lakes and consisted of two transects from 0.5 m to 6.5 m on each of the three sites. The search time was adjusted depending on the lake bottom, but the average transect took 30 minutes. The animals caught within each 2 m depth interval were recorded separately. The animals caught were identified to species, sexed and carapace length measured.

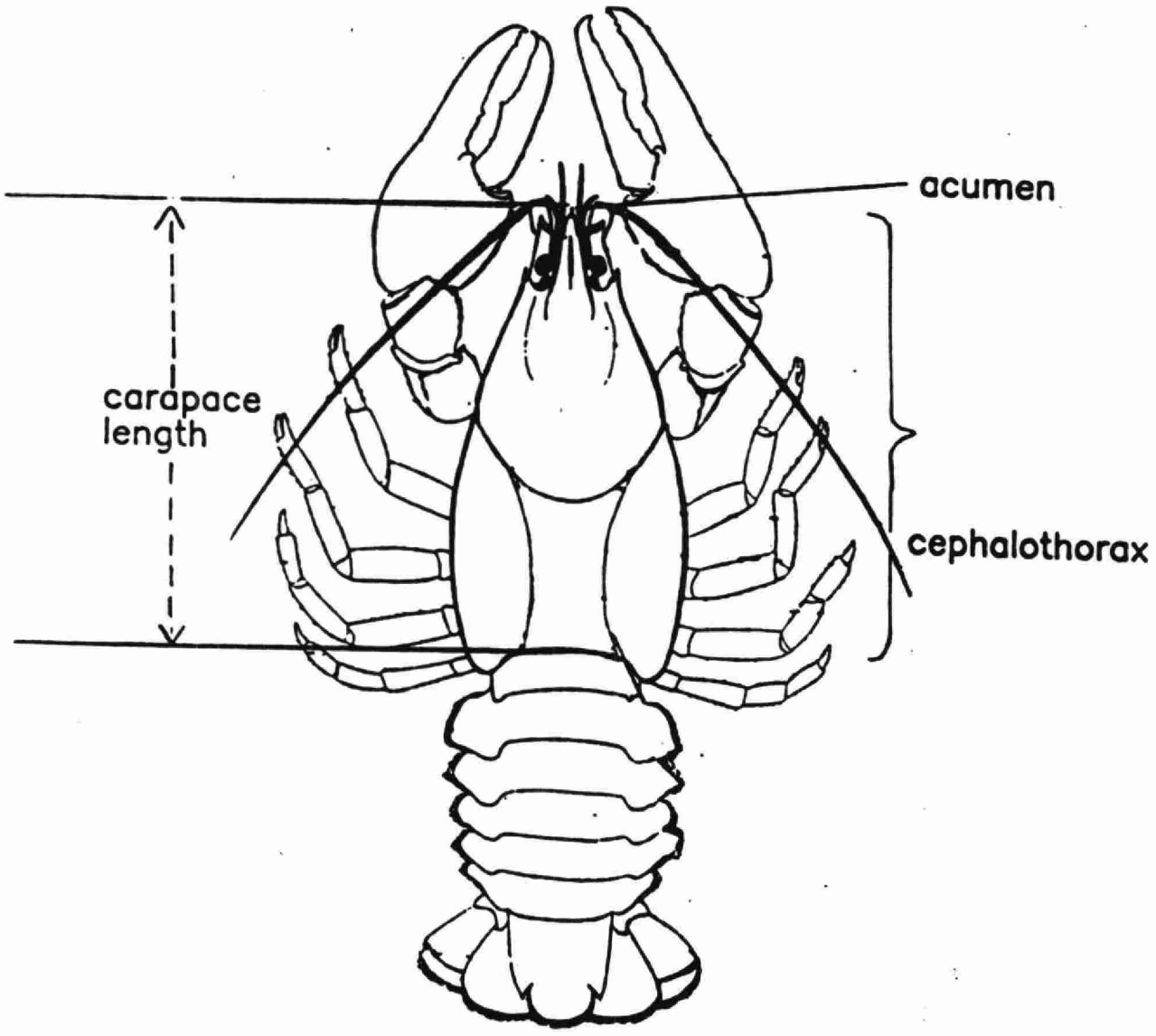


Figure 2: Dorsal view of the crayfish, indicating the measurement used for carapace length.

RESULTS

Lake Chemistry

The chemistry data (Table 2) represents a mid-lake 0-5 m composite sample taken during the trapping survey. The survey lakes have a range for pH (5.33 to 6.82); Ca (1.43 to 3.08 $mg.L^{-1}$); alkalinity (-0.21 to 4.00 $mg.L^{-1}$ as $CaCO_3$).

Crayfish Trap Catch Data

Three species of crayfish were present in the twelve study lakes: Cambarus bartoni, Orconectes propinquus and Orconectes virilis (Table 3). Crayfish were found in all lakes with the exception of Plastic Lake. No crayfish have been found in Plastic Lake since 1981 (Nick Collins, per. com.). Two lakes had all three species (Blue Chalk and Delano), four had two species and five had one species.

Several crayfish researchers have reported a sex bias in trap catch data. Capelli (1975, 1982) and Davies (1989) found the catch of males to exceed that of females.

Overall, this study indicated the greatest male bias for the species O. virilis (58% ♂: 42% ♀), and a lesser bias, on average, for C. bartoni (51% ♂: 49% ♀). For O. propinquus there was a slight bias towards females (51% ♀: 49% ♂) (Figure 3).

The mean number of crayfish caught per traps per night ranged from 0 (Plastic Lake) to 12.7 (Cradle Lake) (Figure 4).

The catch per trap data of total number of crayfish caught and species composition varied both among the sites on each lake and among all of the lakes surveyed. Two factors which may contribute to the variation were the substrate type (rocks, macrophyte or detritus) and trap depth (1-6 m) (Appendix 2).

Table 2: Chemical and physical data for the twelve study lakes.

Parameter		Blue Chalk	Clear	Cradle	Crosson	Delano	Hamer	Harp	Pincher	Plastic	Skidway	Westward	Young
Latitude		45°12'	45°11'	45°28'	45°05'	45°31'	45°14'	45°23'	45°34'	45°11'	45°12'	45°29'	45°13'
Longitude		78°56'	78°43'	78°35'	79°02'	78°36'	79°48'	79°07'	78°51'	78°50'	79°52'	78°47'	79°33'
Area	(ha)	52.4	88.4	17.9	56.7	23.9	35.2	71.4	42.1	32.1	18.5	63.3	105.9
Elevation	(m)	336	369	472.4	312	442	221	328.6	510.5	376.4	221.0	429.0	251.5
Mean Depth	(m)	8.5	12.4	12.44	9.2	7.1	3.3	13.32	6.06	7.9	2.89	20.5	12.03
Maximum Depth	(m)	23.0	33.0	33.3	25.0	18.6	8.5	37.5	15.5	16.3	7.8	44.0	21.1
Alkalinity	(as $CaCO_3$)	4.00	0.077	0.24	0.52	2.43	0.63	3.66	-0.13	0.14	-0.21	1.79	4.69
Ca mg/L		2.75	2.42	1.62	2.35	2.48	3.08	3.00	1.48	1.88	1.43	1.88	2.60
Cl mg/L		0.60	0.46	0.34	0.50	0.30	1.70	0.93	0.30	0.75	0.30	0.21	0.36
COND25 µmhos/cm		29.2	25.8	21.9	30.2	30.8	31.1	34.2	21.5	21.8	20.3	23.6	30.6
DIC mg/L		1.12	0.25	0.25	0.32	0.66	0.34	0.99	0.16	1.16	0.36	0.58	0.52
DOC mg/L	(as C)	1.90	1.77	1.67	4.03	4.60	7.23	3.67	2.17	2.18	3.17	1.87	3.47
F µg/L		28.1	50.8	41.0	41.9	44.2	43.8	31.1	43.5	50.7	52.2	37.0	39.8
K mg/L		0.46	0.36	0.30	0.32	0.42	0.45	0.56	0.35	0.21	0.22	0.35	0.58
Mg mg/L		0.86	0.57	0.47	0.67	0.90	0.69	0.95	0.44	0.49	0.46	0.55	0.74
Na mg/L		0.88	0.50	0.45	0.66	0.78	0.87	1.28	0.55	0.51	0.58	0.52	0.93
NH_4 µg/L	(as N)	9.0	6.3	10.0	28.3	11.0	4.3	2.3	7.3	9.5	8.3	7.3	9.0
NO_2 + NO_3 µg/L	(as N)	1.5	1.7	4.3	2.0	6.0	2.3	2.0	20.7	5.8	3.3	4.0	5.7
TKN µg/L	(as N)	210	150	167	305	260	317	223	177	187	277	155	277
pH		6.82	5.84	5.95	5.95	6.50	5.59	6.79	5.55	5.86	5.33	6.64	6.80
Phosphorus µg/L		5.0	3.8	4.0	9.4	6.1	12.2	7.5	5.6	4.7	8.5	3.9	8.3
SO_4 mg/L	(as SO_4	6.6	8.2	6.9	7.6	8.1	7.2	6.9	6.9	6.5	5.5	6.0	6.7

Table 3: Number of crayfish collected (all species) in the 12 study lakes.

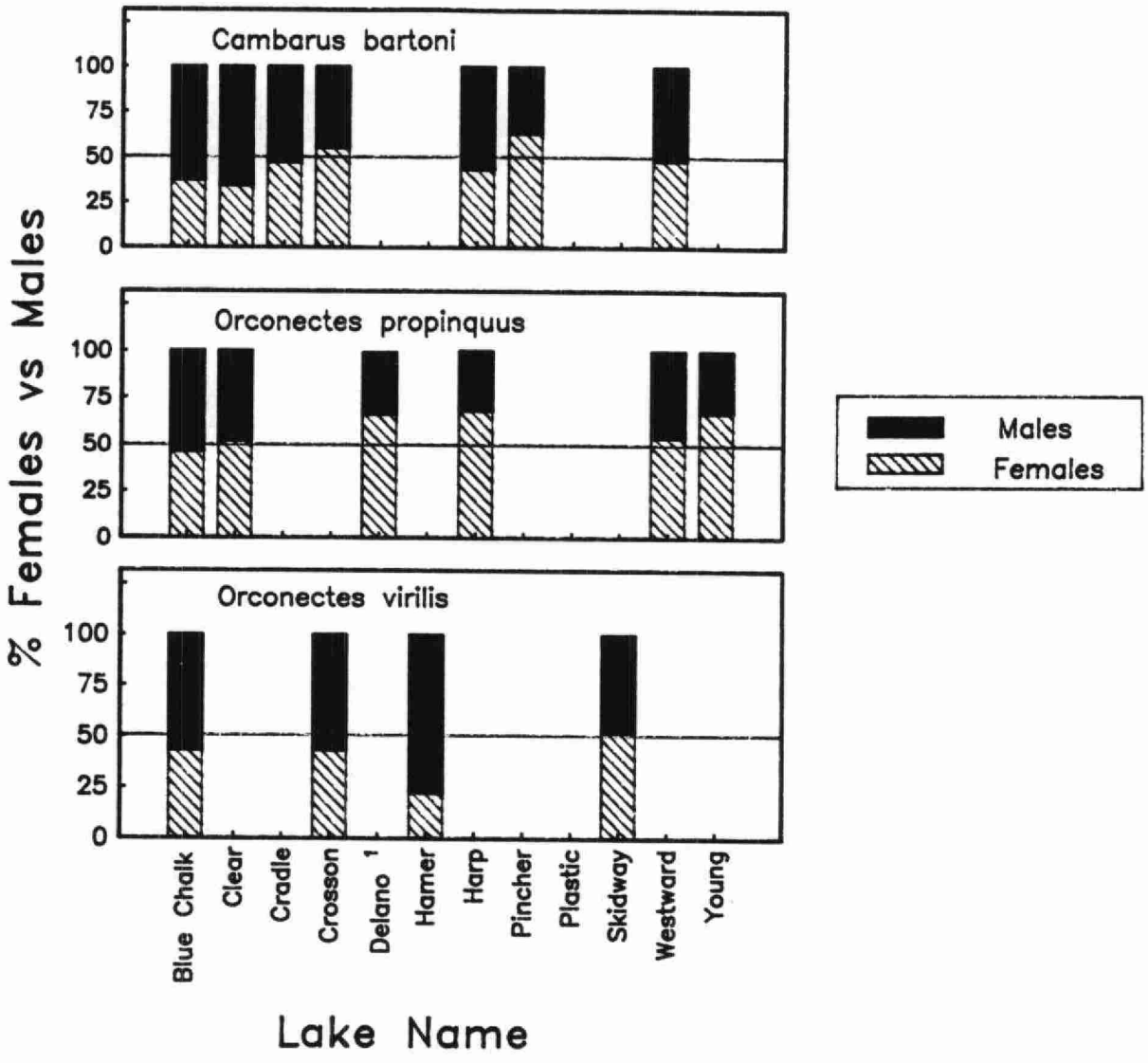
Lake	Date Sampled	Number of Traps	Number Collected[1]		Species[2]	
			Trap	Dive	Trap	Dive
Blue Chalk	21-22 July	178	1,125	45	CP, OP, OV	CB, OP, OV
Clear	24-25 July	154	469	33	CB, OP	CB, Op
Cradle	29-30 August	180	2,282	58	CB	CB
Crosson	19-20 July	155	473	23	CB, OV	CB, OV
Delano	10-11 August	180	163	10	CB, OP, OV	OP
Hamer	3-4 August	160	66	6	OV	OV
Harp	27-28 July	180	30	3	CB, OP	OP
Plastic	17-18 July	180	0	0	----	----
Pincher	24-28 August	180	487	0	CB	----[3]
Skidway	2-3 August	160	54	1	OV	OV
Westward	16-17 August	179	1,144	70	CB, OP	CB, OP
Young	8-9 August	180	4,343	26	OP	OP, CB

[1] Actual numbers caught by traps and divers.

[2] CB - Cambarus bartoni
OP - Orconectes propinquus
OV - Orconectes virilis

[3] No dive

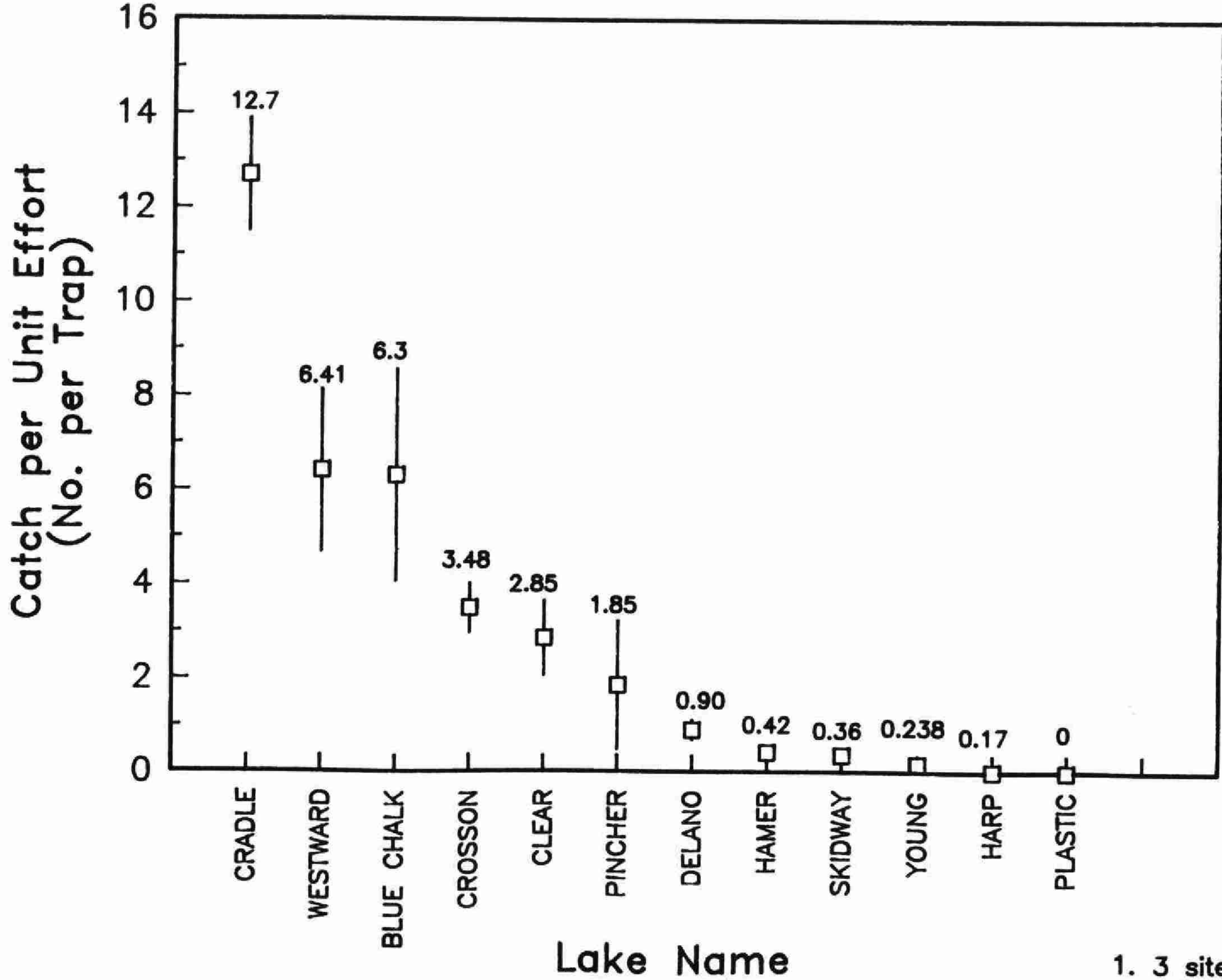
Figure 3 : Female Male Catch Comparison



% Catch by Species		
	Female	Male
CB	49% (2001)	51% (2115)
OP	51% (750)	49% (720)
OV	42% (300)	58% (419)

1. Delano Lake – 1 Cambarus bartoni (female) and 2 Orconectes virilis (male) were caught in the traps.

Figure 4 : Catch per Unit Effort on the Twelve Study Lakes[1]



1. 3 sites per lake; 60 traps per site.

Divers assessed the population on portion (approximately 16%) of the trapped area. The number of crayfish caught by the divers and in the traps are compared in Figure 5.

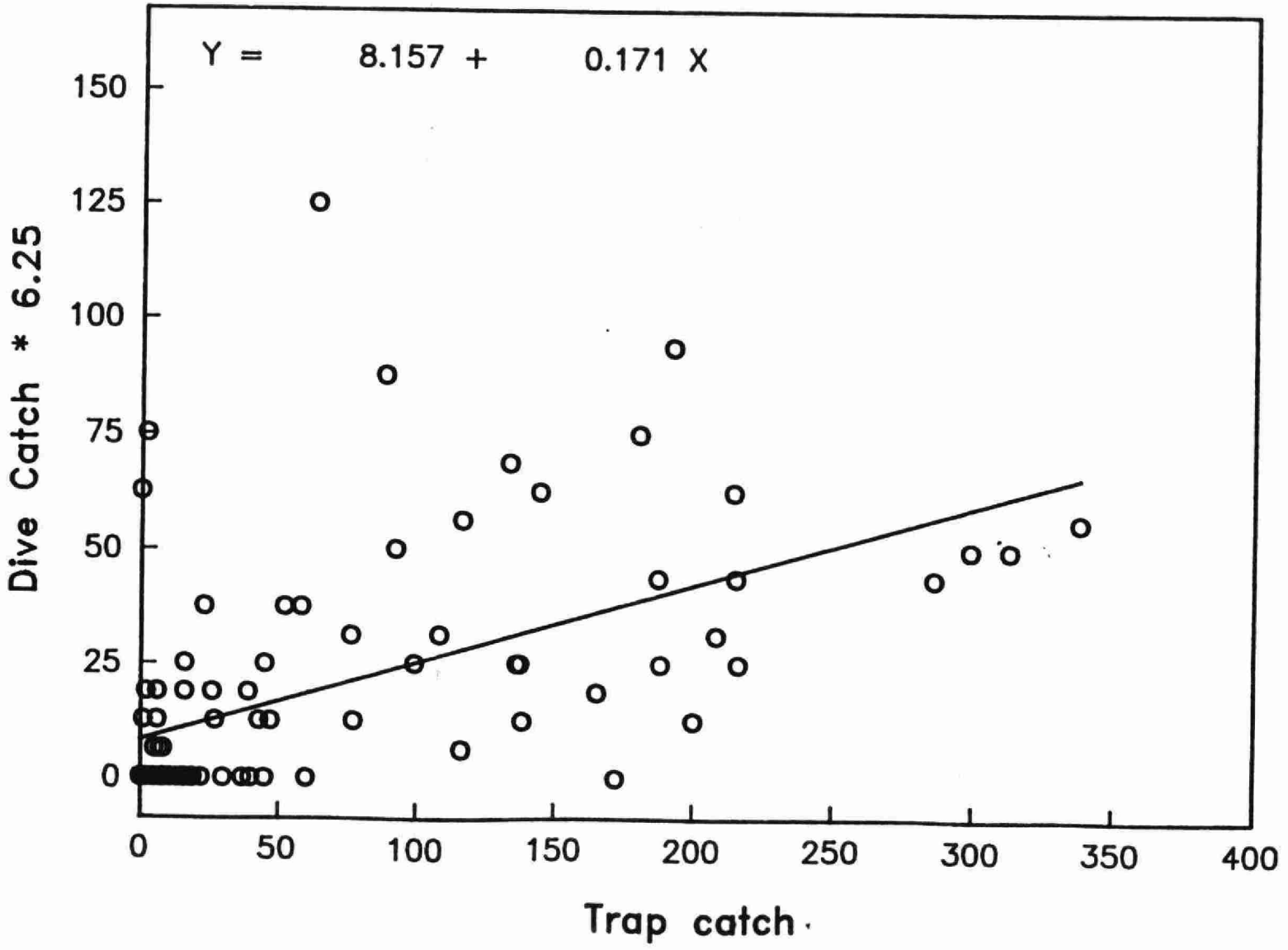
The carapace length data for the trapped crayfish appears to be normally distributed (Appendix 3). Mean values for C. bartoni ranged from 22.2 mm to 36.3 mm; for O. propinquus from 19.8 mm to 28.4 mm and for O. virilis from 26.1 mm and 38.0 mm (Appendix 3).

The carapace length: wet weight relationships (Appendix 4) include all of the data collected except Blue Chalk, Cradle and Westward Lakes where only 526, 299 and 507 crayfish respectively were measured (Appendix 4).

ACKNOWLEDGEMENTS

The authors would like to thank Mike Berrill and Graeme Taylor for their expertise in carrying out the SCUBA diving portion of the field sampling programme in 1988. We are also thankful to Shelley Zeran and Cheryl Partridge for their field assistance, and Sheryl Gleave for the typing of this manuscript.

Figure 5: Comparison of Trap and Dive Data



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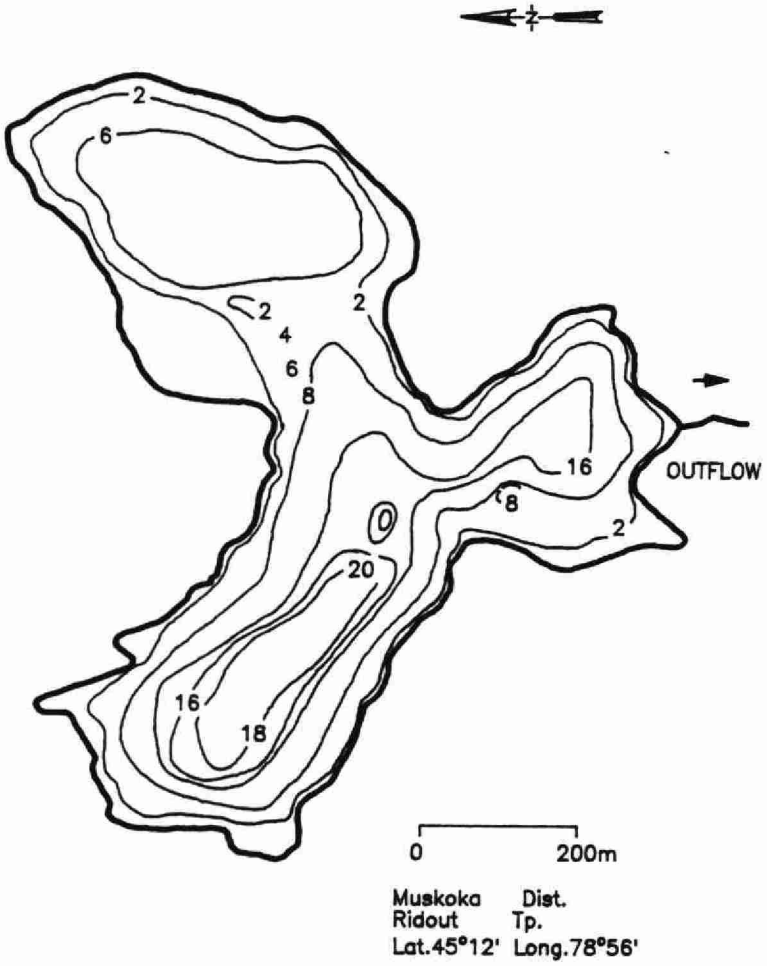
Appendix 1: Morphometry

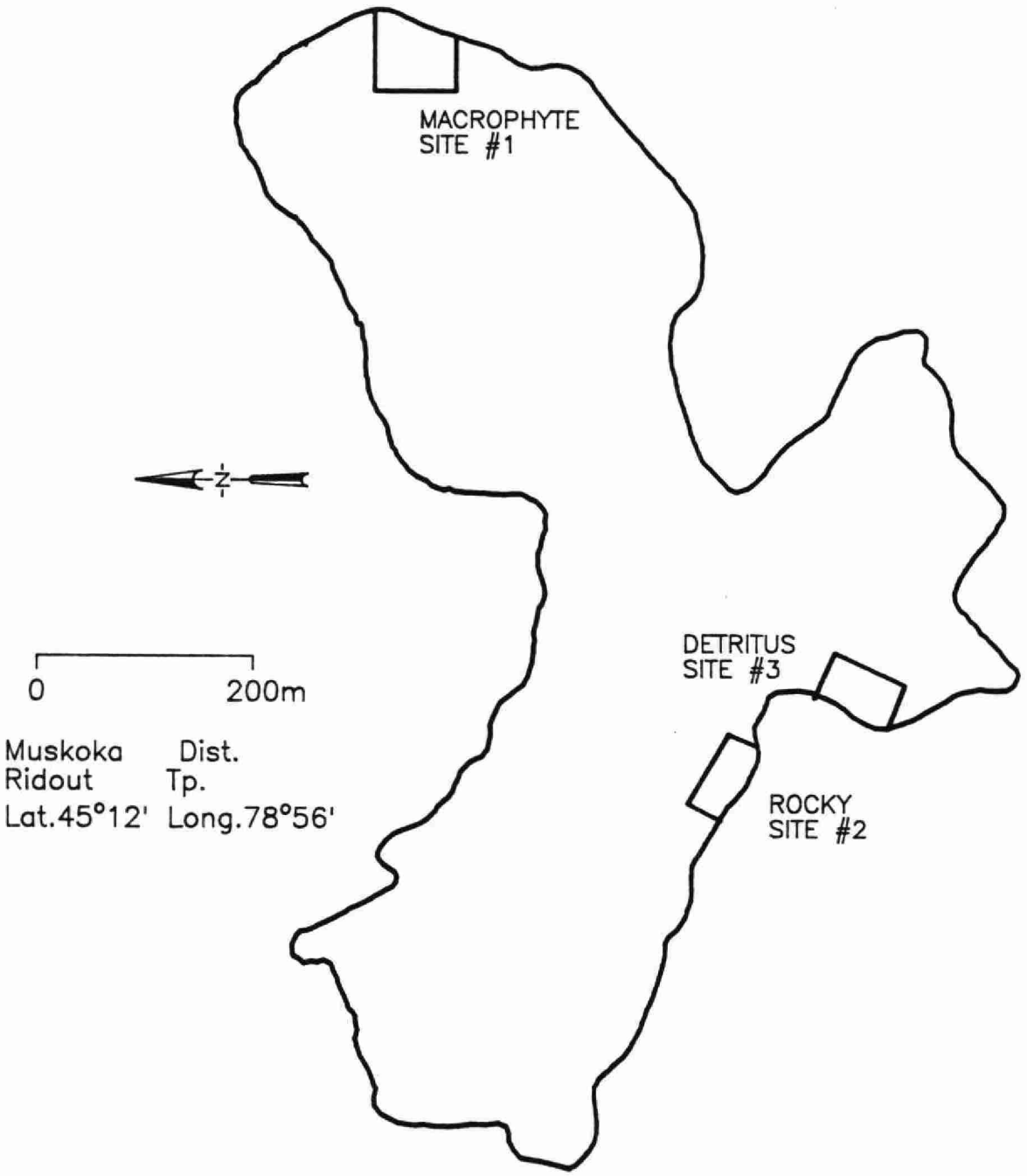
Blue Chalk Lake



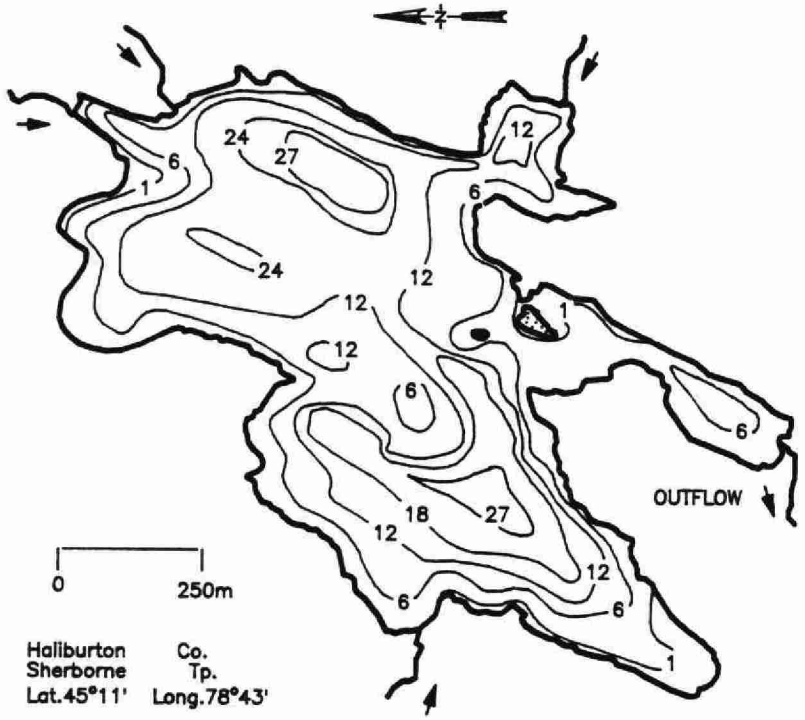
Area (ha)	Volume ($m^3 x 10^5$)	Mean Depth (m)	Maximum Depth (m)	Shoreline Length (km)
52.35	44.68	8.5	23	4.67

Contour Depth (m)	Contour Area (ha)	Stratum Volume ($m^3 x 10^5$)
0	52.35	
		9.42
2	42.08	
		7.83
4	36.28	
		6.74
6	31.14	
		5.55
8	24.52	
		4.19
10	17.56	
		3.29
12	15.34	
		2.79
14	12.64	
		2.28
16	10.22	
		1.49
18	5.02	
		0.79
20	2.93	
		0.29
22	0.38	
		0.01
23	0	

Blue Chalk Lake – trap site locations



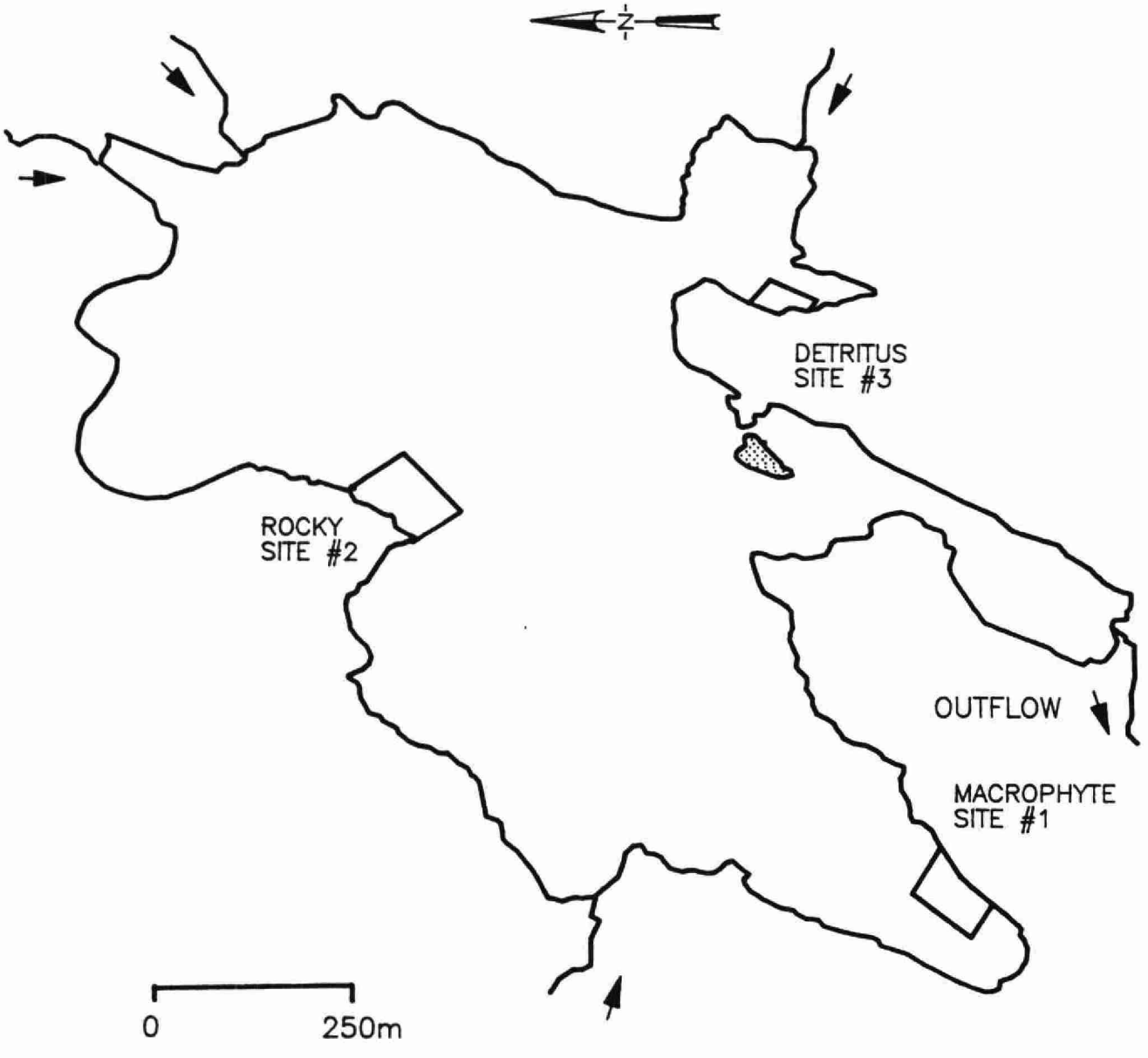
Clear Lake



Area (ha)	Volume (m3*105)	Mean Depth (m)	Maximum Depth (m)	Shoreline Length (km)
88.4	109.1	12.4	33.0	6.73

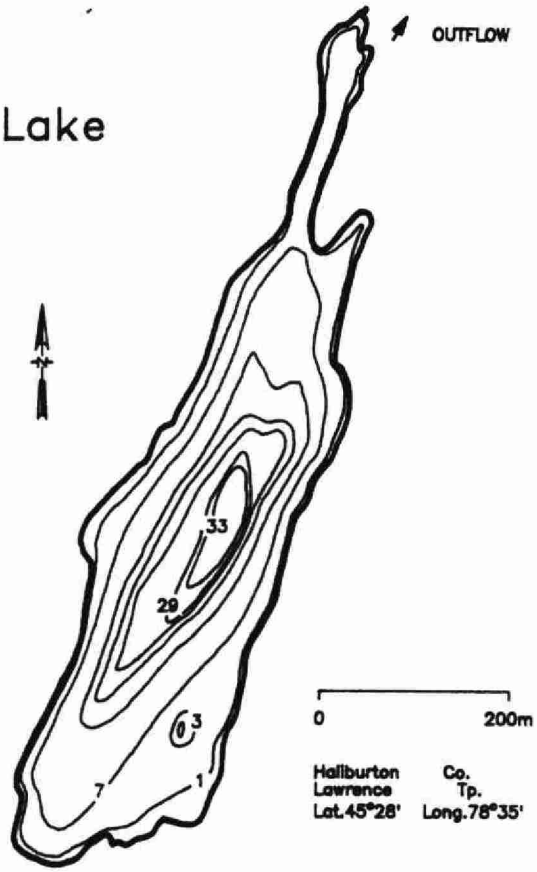
Contour Depth (m)	Contour Area (ha)	Stratum Volume (m3*105)
0	88.40	
		16.50
2	77.00	
		14.30
4	66.40	
		12.50
6	58.40	
		11.10
8	52.70	
		10.00
10	47.30	
		8.89
12	41.60	
		7.79
14	36.30	
		6.73
16	31.10	
		5.70
18	26.00	
		4.72
20	21.30	
		3.76
22	16.40	
		2.84
24	12.10	
		2.03
26	8.28	
		1.32
28	5.04	
		0.75
30	2.60	
		0.25
33	0.30	

Clear Lake – trap site locations



Haliburton Co.
Sherborne Tp.
Lat.45°11' Long.78°43'

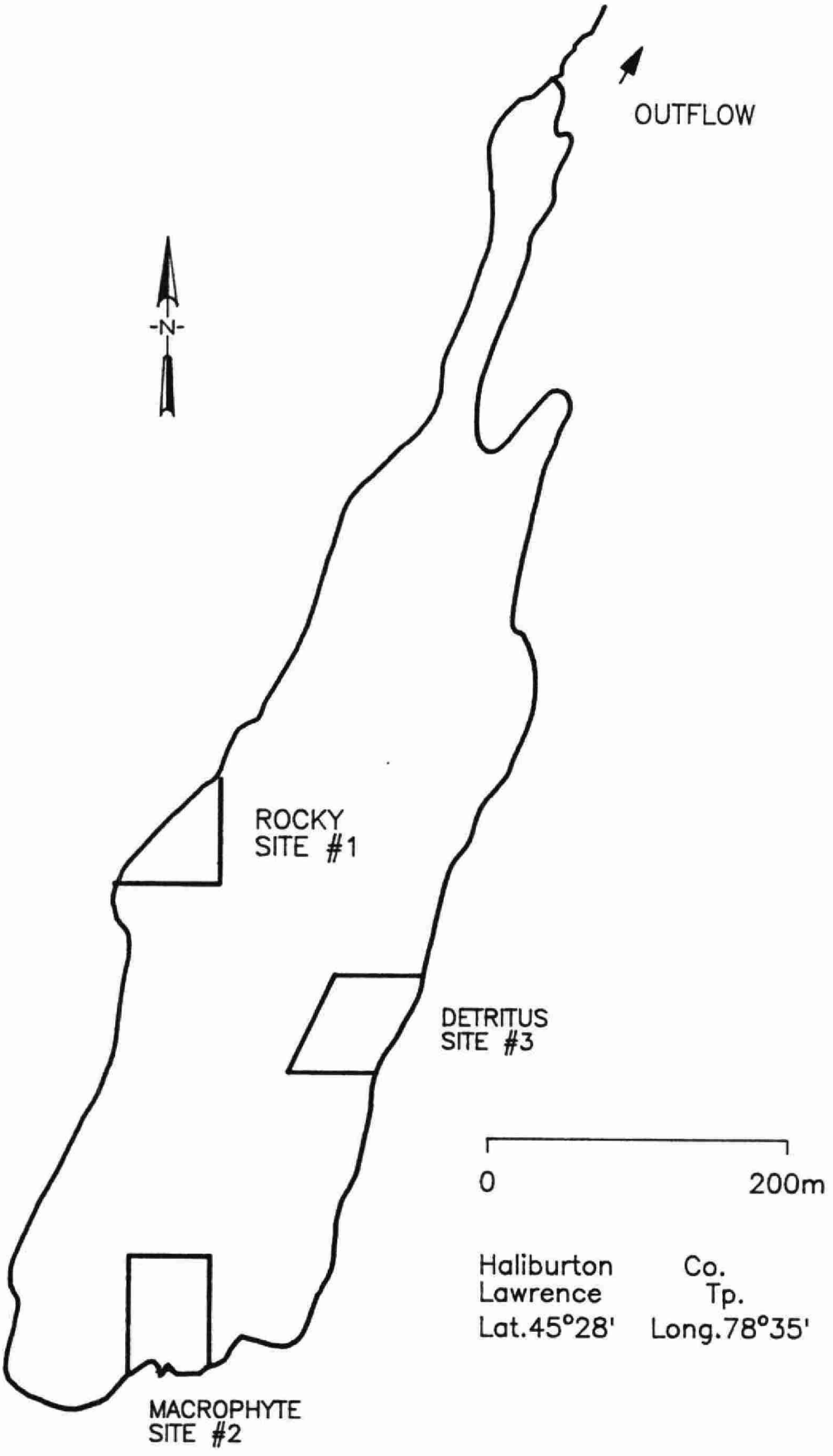
Cradle Lake



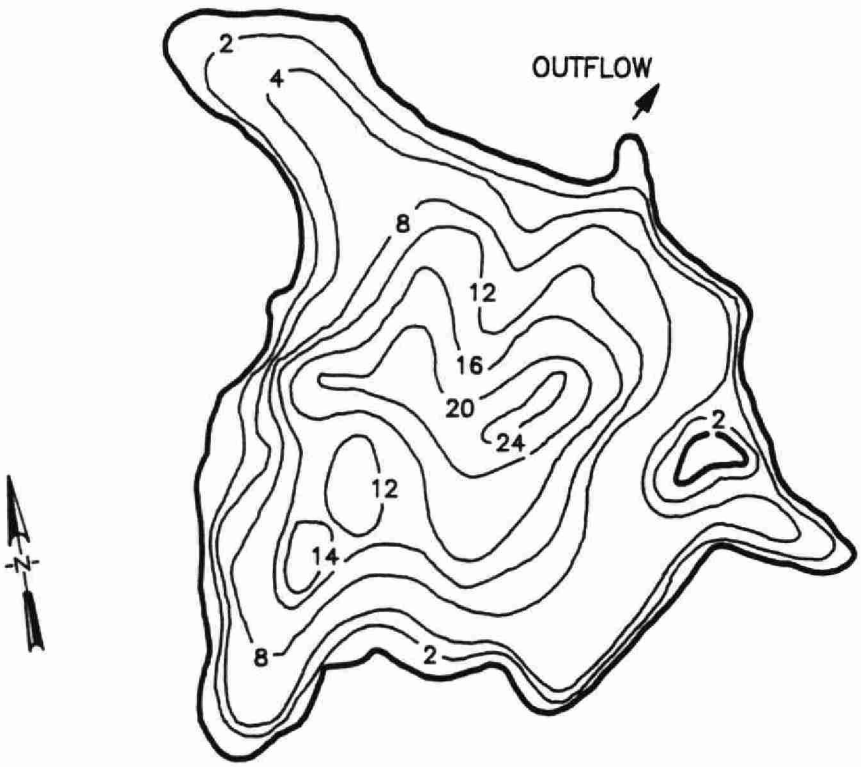
Area (ha)	Volume ($m^3 x 10^5$)	Mean Depth (m)	Maximum Depth (m)	Shoreline Length (km)
17.89	22.25	12.44	33.3	2.44

Contour Depth (m)	Contour Area (ha)	Stratum Volume ($m^3 x 10^5$)
0	17.89	
		3.42
2	16.34	
		3.11
4	14.74	
		2.77
6	12.78	
		2.35
8	10.86	
		2.00
10	9.04	
		1.63
12	7.50	
		1.38
14	6.24	
		1.13
16	5.25	
		0.99
18	4.56	
		0.85
20	3.96	
		0.74
22	3.42	
		0.63
24	2.87	
		0.52
26	2.39	
		0.41
28	1.42	
		0.19
30	0.65	
		0.10
32	0.40	
		0.04
33.3	0	

Cradle Lake — trap site locations



Crosson Lake



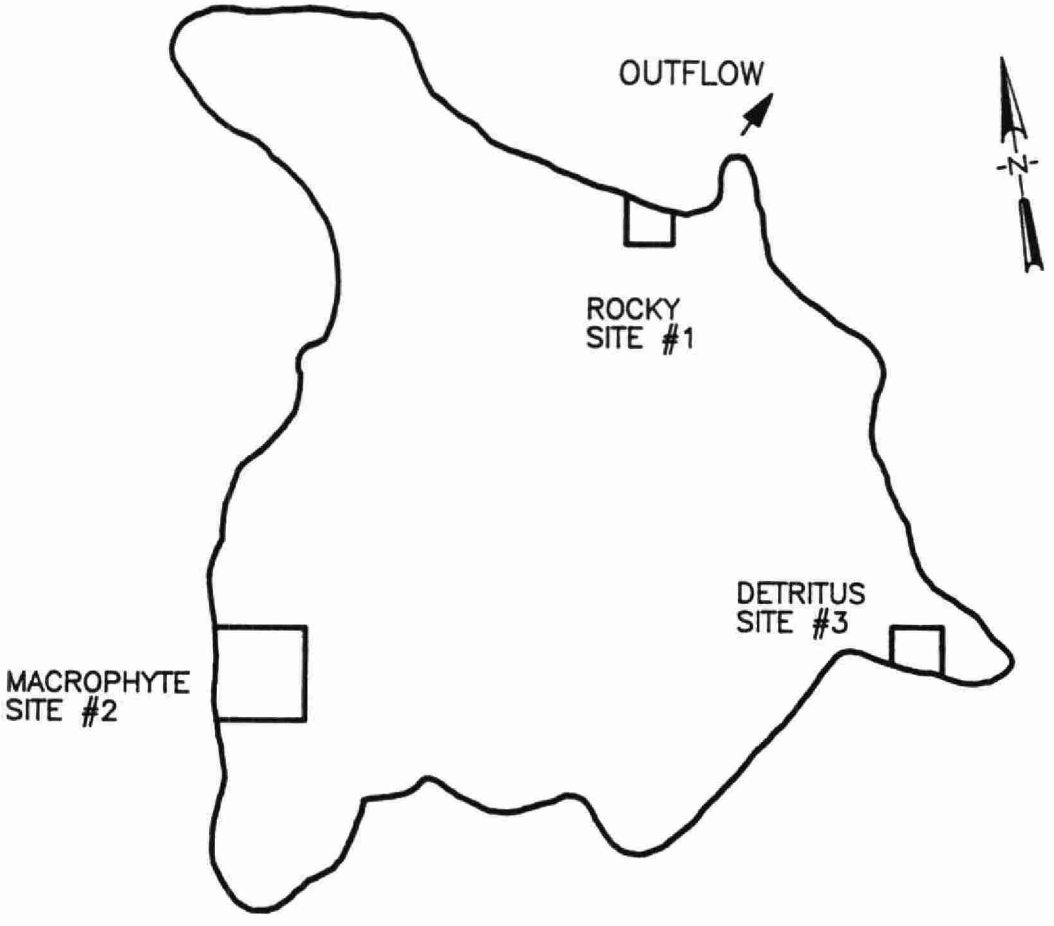
0 500m

Muskoka Dist.
Oakley Tp.
Lat. 45° 05' Long. 79° 02'

Area (ha)	Volume ($m^3 \times 10^5$)	Mean Depth (m)	Maximum Depth (m)	Shoreline Length (km)
56.74	52.16	9.2	25.0	4.40

Contour Depth (m)	Contour Area (ha)	Stratum Volume ($^3 \times 10^5$)
0	56.74	
		10.70
2	50.28	
		9.30
4	42.80	
		7.74
6	34.75	
		6.14
8	26.83	
		4.89
10	22.13	
		3.98
12	17.77	
		3.14
14	13.75	
		2.36
16	9.92	
		1.73
18	7.48	
		1.26
20	5.15	
		0.67
22	1.83	
		0.23
24	0.58	
		0.02
25	0	

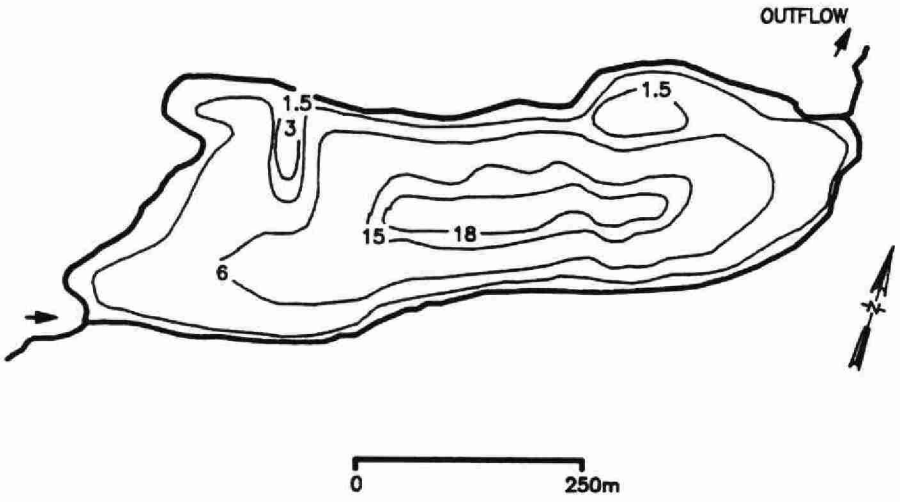
Crosson Lake – trap site locations



0 500m

Muskoka Dist.
Oakley Tp.
Lat. 45° 05' Long. 79° 02'

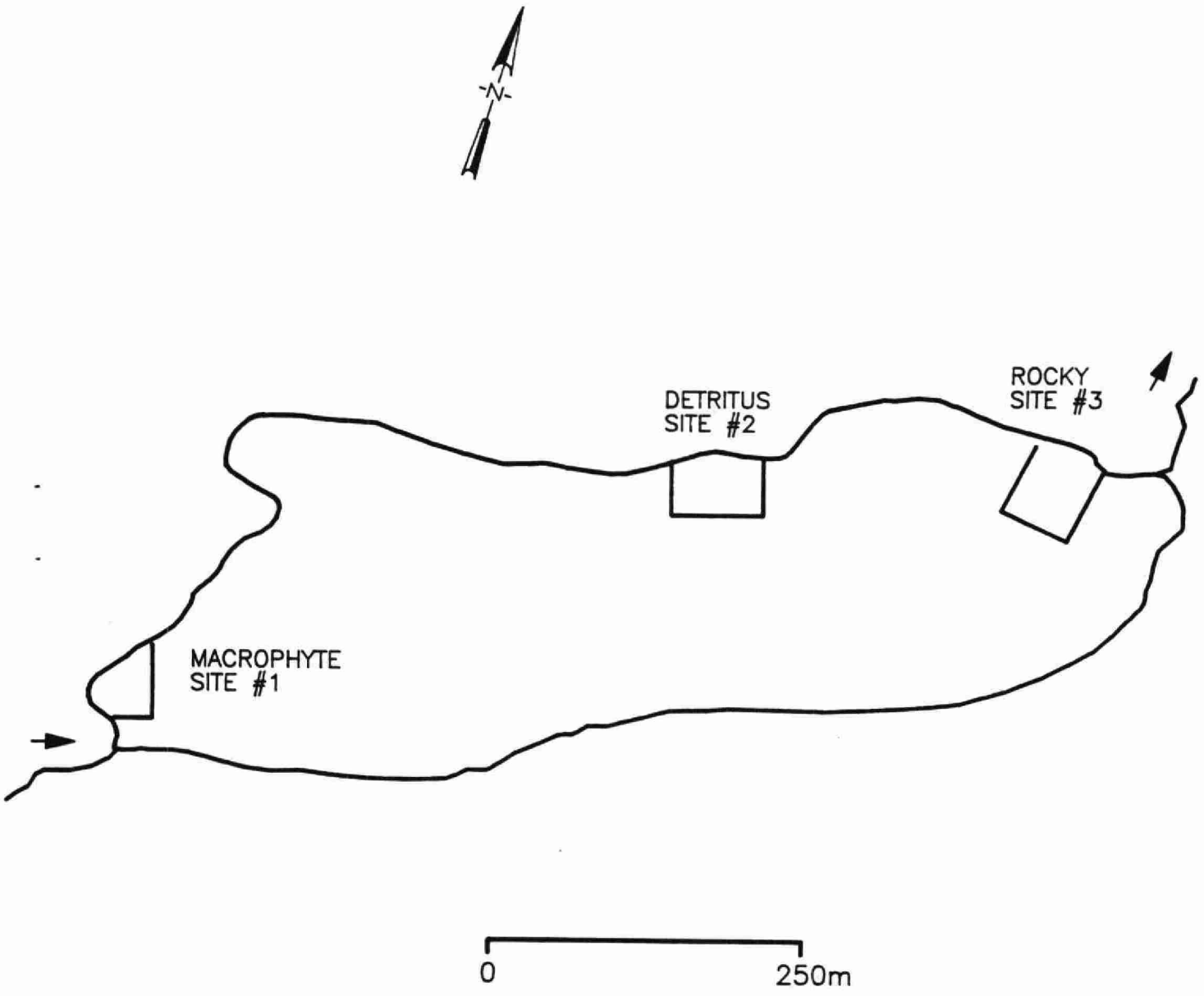
Delano Lake



Area (ha)	Volume (m3*105)	Mean Depth (m)	Maximum Depth (m)	Shoreline Length (km)
23.9	17.0	7.1	18.6	1.99

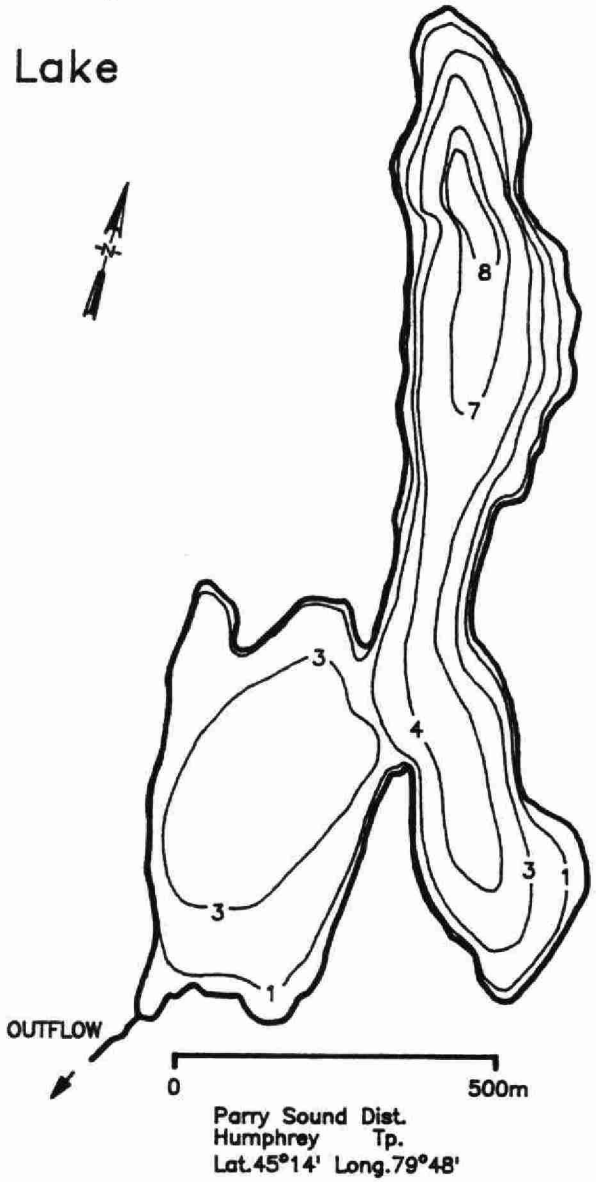
Contour Depth (m)	Contour Area (ha)	Stratum Volume (m3*105)
0	23.9	
		4.27
2	18.9	
		3.25
4	13.7	
		2.45
6	10.8	
		1.98
8	9.01	
		1.61
10	7.13	
		1.29
12	5.79	
		1.01
14	4.36	
		0.710
16	2.80	
		0.432
18	1.58	
		0.032
18.6	0	

Delano Lake — trap site locations



Nipissing Dist.
Canisbay Tp.
Lat.45°31' Long.78°36'

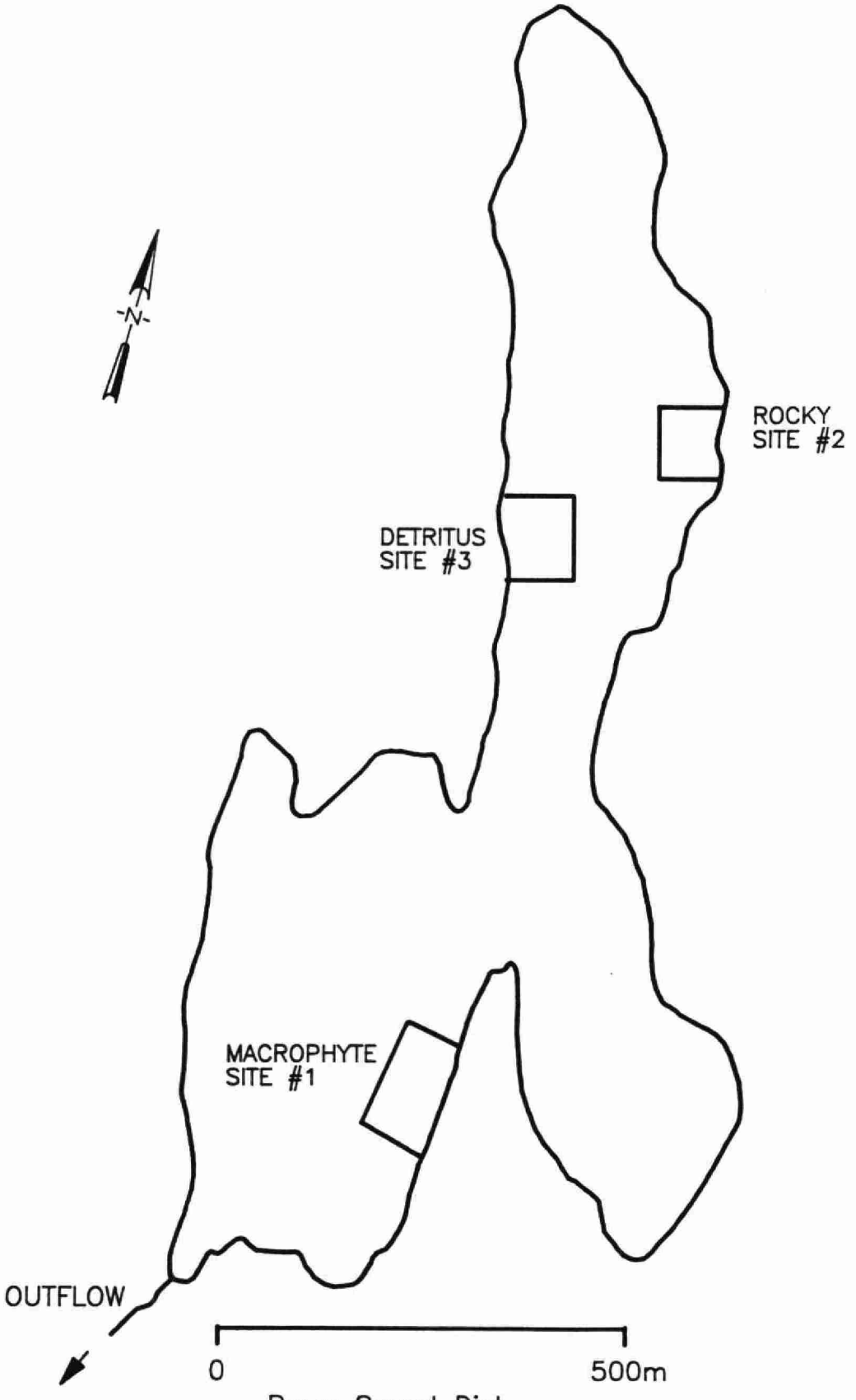
Hamer Lake



Area	Volume	Mean Depth	Maximum Depth	Shoreline Length
(ha)	($m^3 x 10^5$)	(m)	(m)	(km)
35.21	11.63	3.30	8.50	4.01

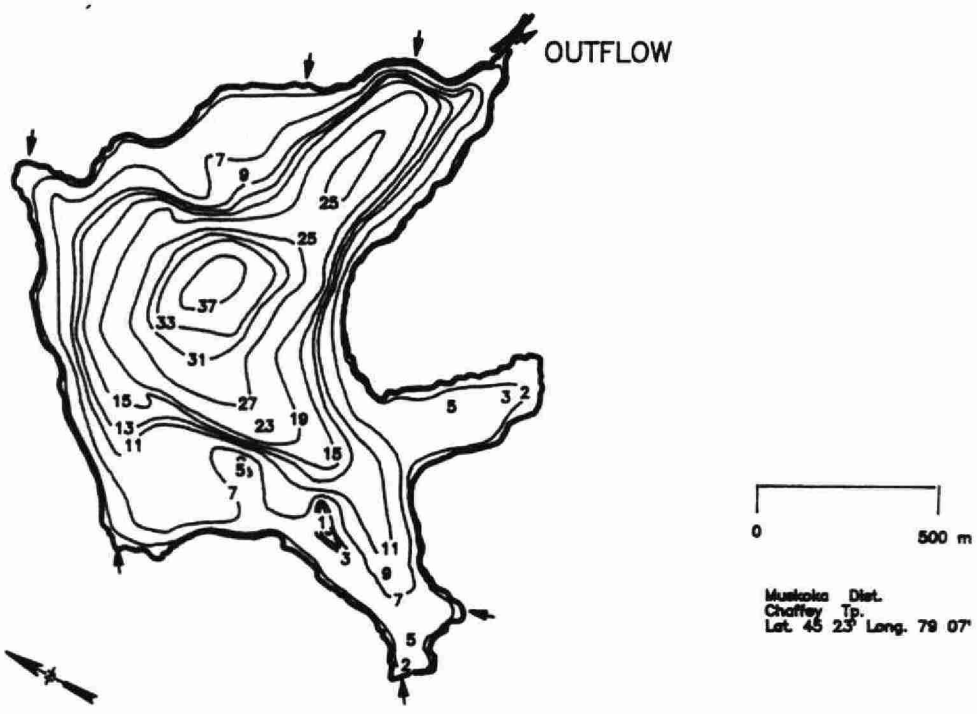
Contour Depth (m)	Contour Area (ha)	Stratum Volume ($^3 x 10^5$)
0	35.21	
		6.20
2	26.84	
		3.93
4	11.19	
		1.12
6	3.11	
		0.39
8.5	0	

Hamer Lake – trap site locations



Parry Sound Dist.
Humphrey Tp.
Lat.45°14' Long.79°48'

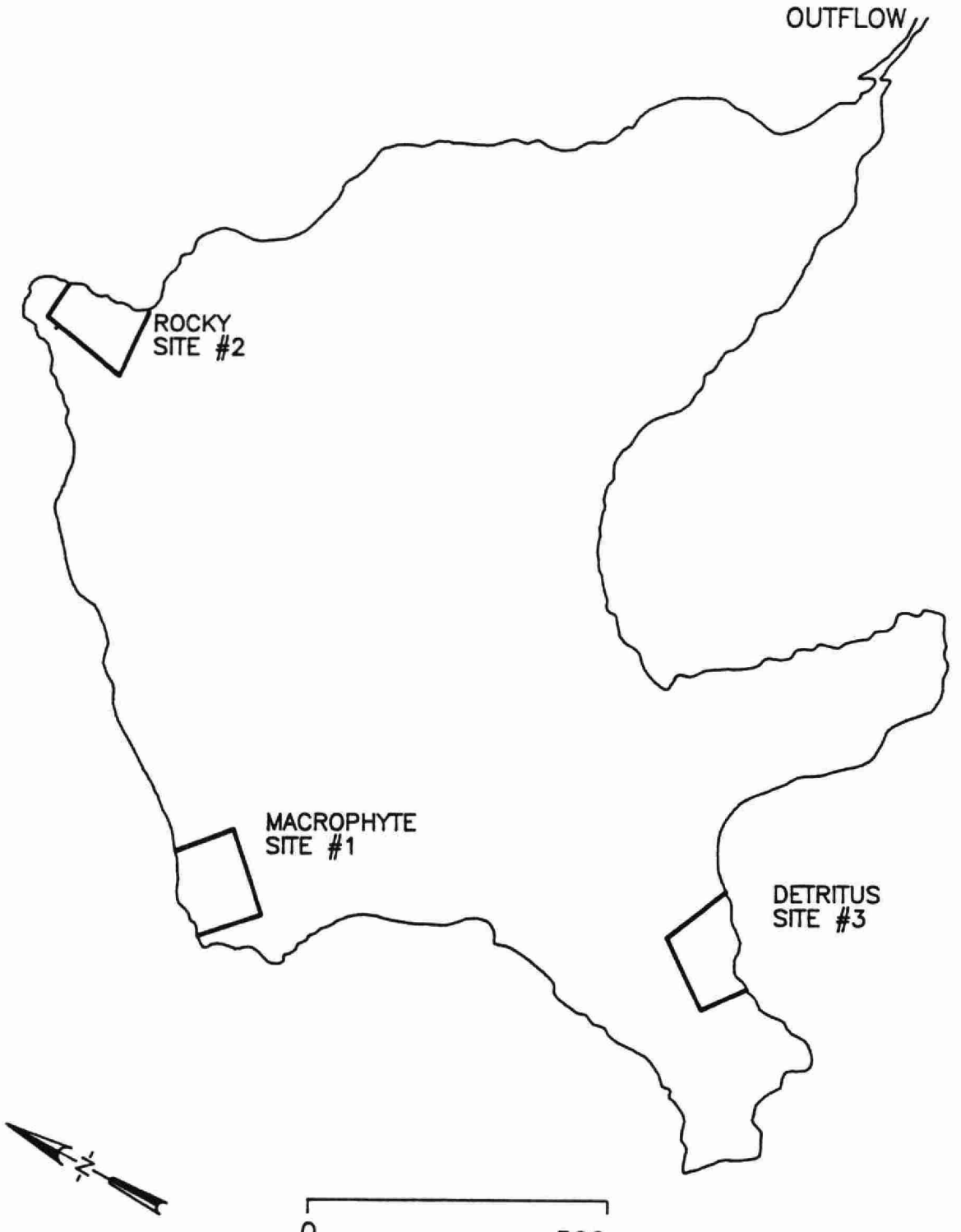
Harp Lake



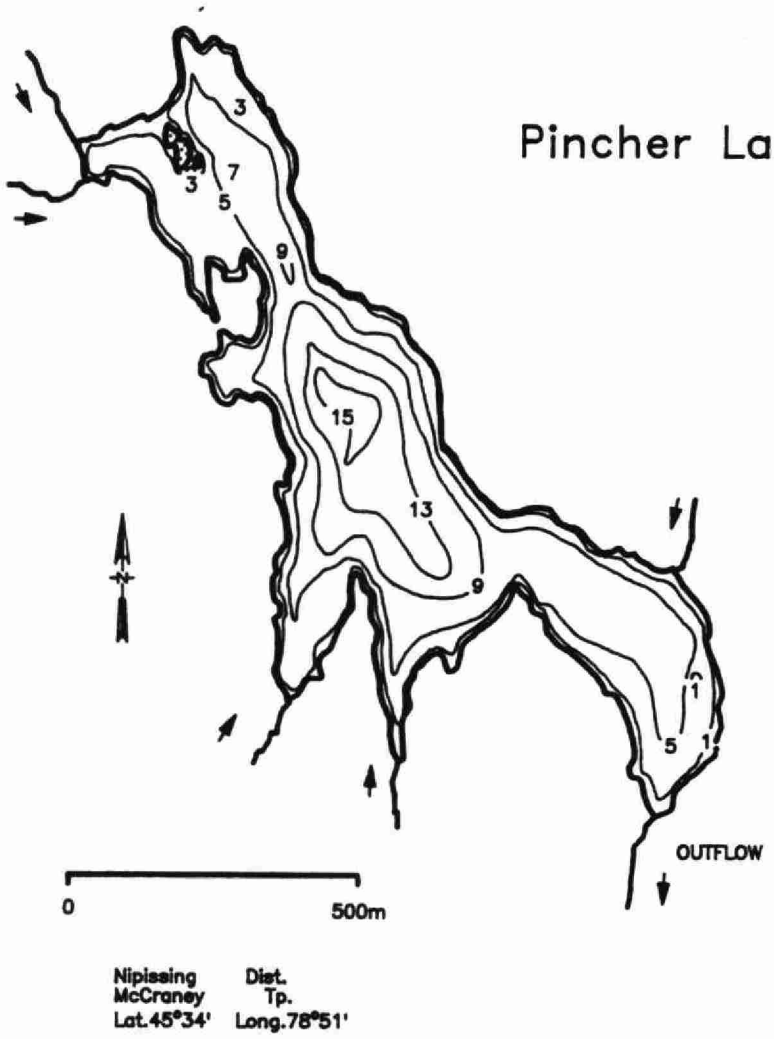
Area (ha)	Volume ($m^3 \times 10^5$)	Mean Depth (m)	Maximum Depth (m)	Shoreline Length (km)
71.38	95.07	13.32	37.5	4.75

Contour Depth (m)	Contour Area (ha)	Stratum Volume ($m^3 \times 10^5$)
0	71.38	
		13.75
2	66.10	
		12.43
4	58.64	
		11.06
6	51.73	
		9.64
8	44.77	
		8.29
10	38.13	
		7.02
12	32.47	
		6.02
14	27.85	
		5.16
16	23.93	
		4.45
18	20.61	
		3.82
20	17.69	
		3.28
22	15.20	
		2.79
24	12.43	
		2.19
26	9.69	
		1.71
28	7.42	
		1.29
30	5.62	
		0.97
32	3.99	
		0.65
34	2.64	
		0.42
36	1.48	
		0.14
37.5	0	

Harp Lake – trap site locations



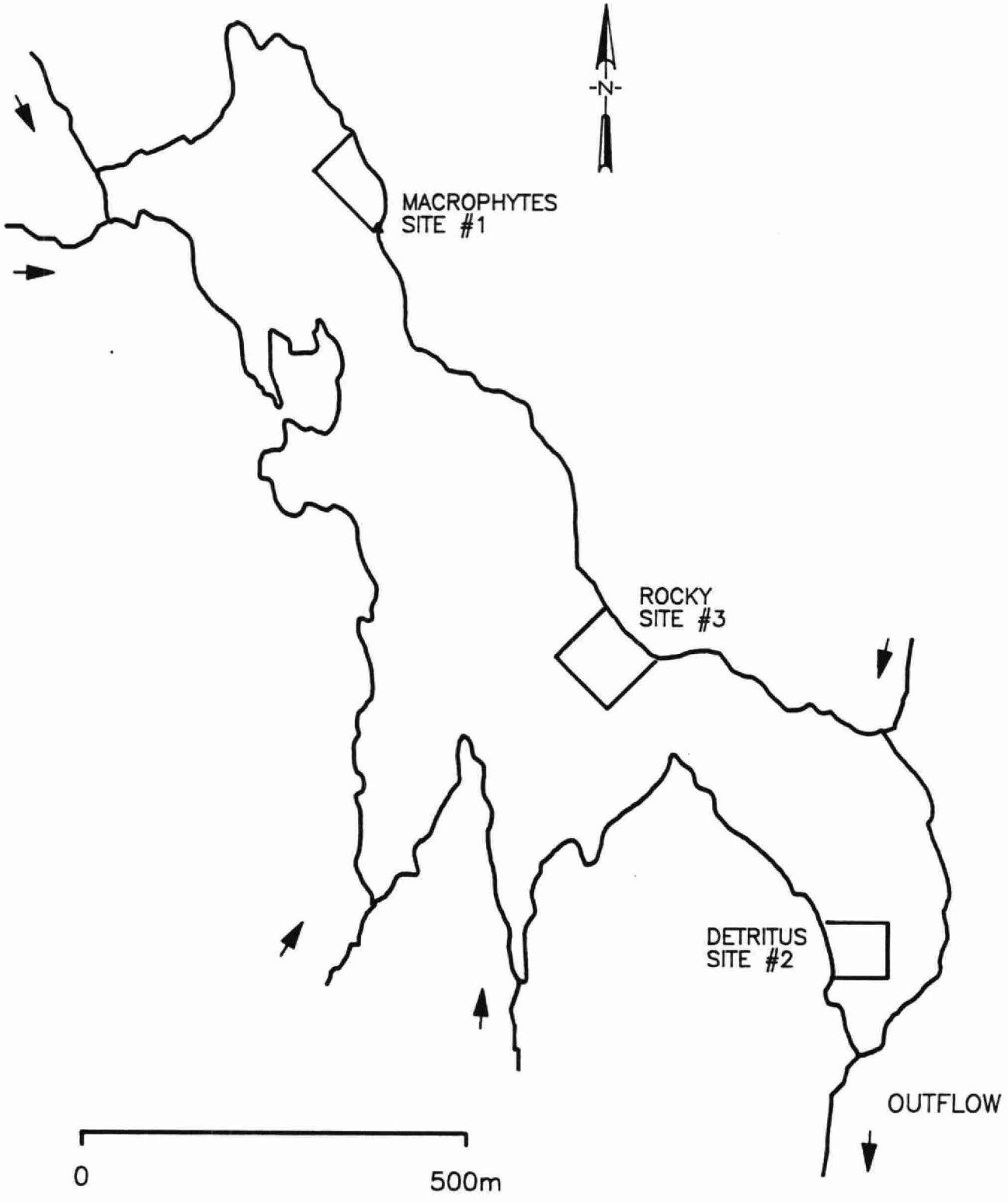
Muskoka Dist.
Chaffey Tp.
Lat. 45°23' Long. 79°07'



Area	Volume	Mean Depth	Maximum Depth	Shoreline Length
(ha)	(m^3x10^5)	(m)	(m)	(km)
42.06	25.48	6.06	15.5	

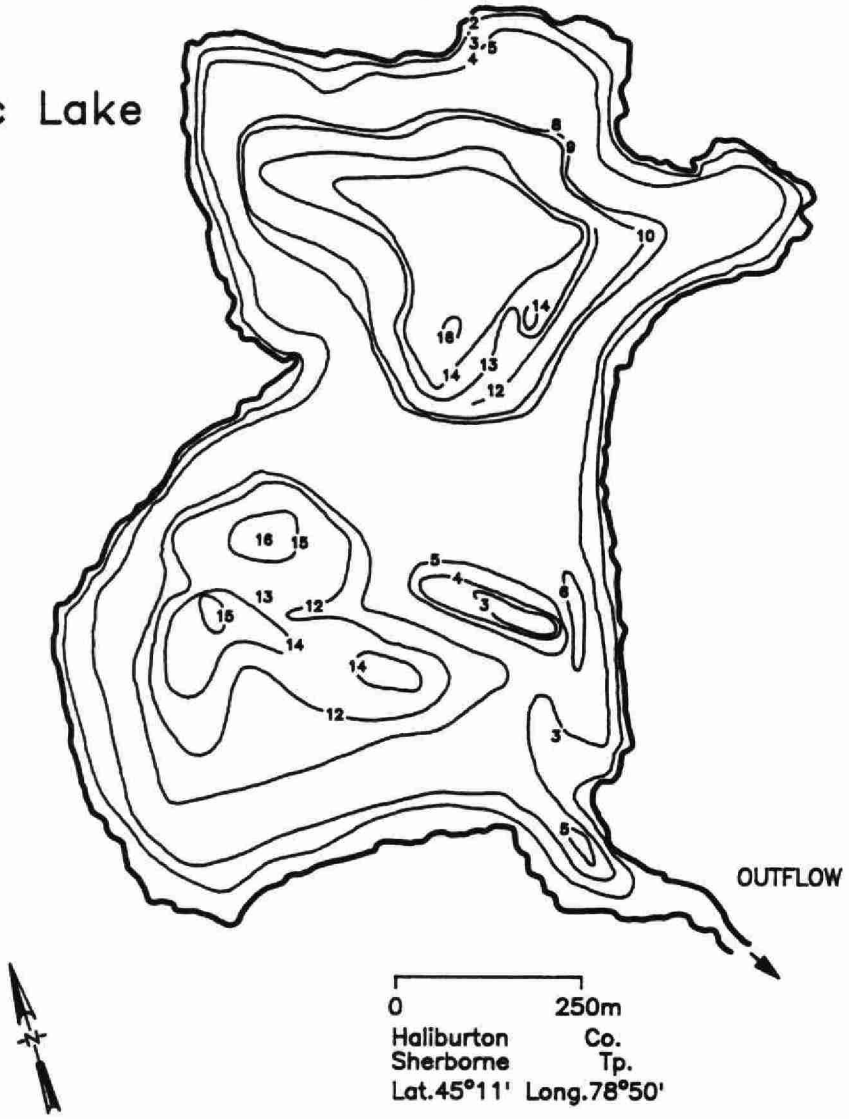
Contour Depth (m)	Contour Area (ha)	Stratum Volume ($^3x10^5$)
0	42.06	
		7.44
2	33.39	
		6.01
4	26.38	
		4.54
6	18.97	
		3.11
8	12.47	
		2.01
10	8.31	
		1.39
12	5.57	
		0.82
14	2.22	
		0.16
15	0	

Pincher Lake – trap site locations



Nipissing Dist.
McCraney Tp.
Lat.45°34' Long.78°51'

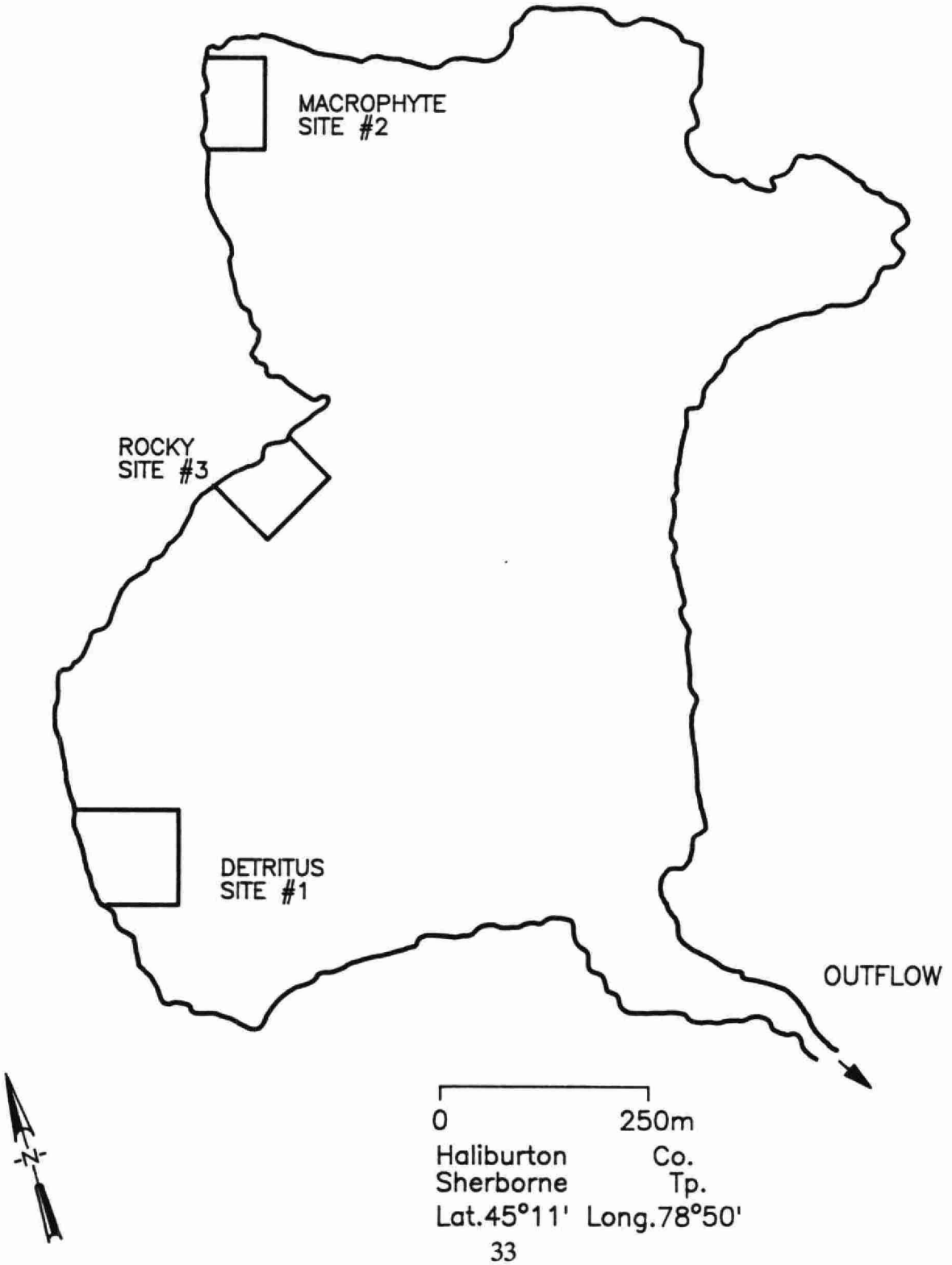
Plastic Lake



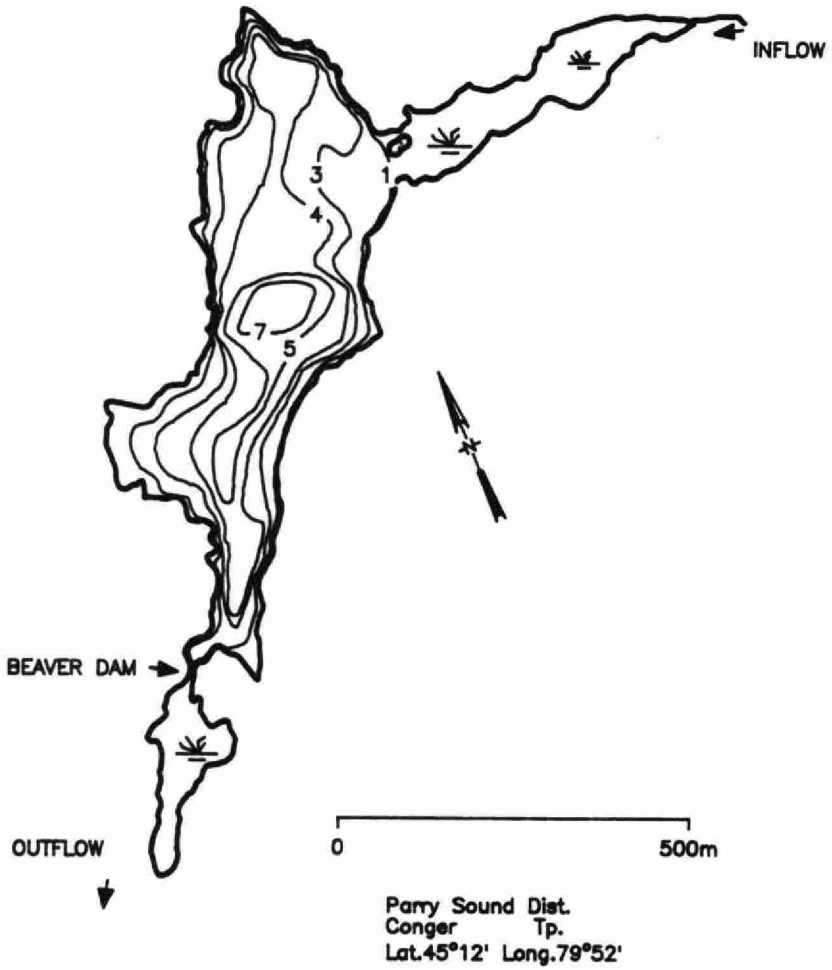
Area (ha)	Volume ($m^3 \times 10^5$)	Mean Depth (m)	Maximum Depth (m)	Shoreline Length (km)
32.14	25.24	7.9	16.3	3.14

Contour Depth (m)	Contour Area (ha)	Stratum Volume ($m^3 \times 10^5$)
0	32.14	
		6.11
2	28.97	
		5.37
4	24.84	
		4.47
6	19.65	
		3.46
8	14.95	
		2.60
10	11.23	
		1.88
12	7.29	
		1.06
14	3.35	
		0.30
16.3	0	

Plastic Lake – trap site locations



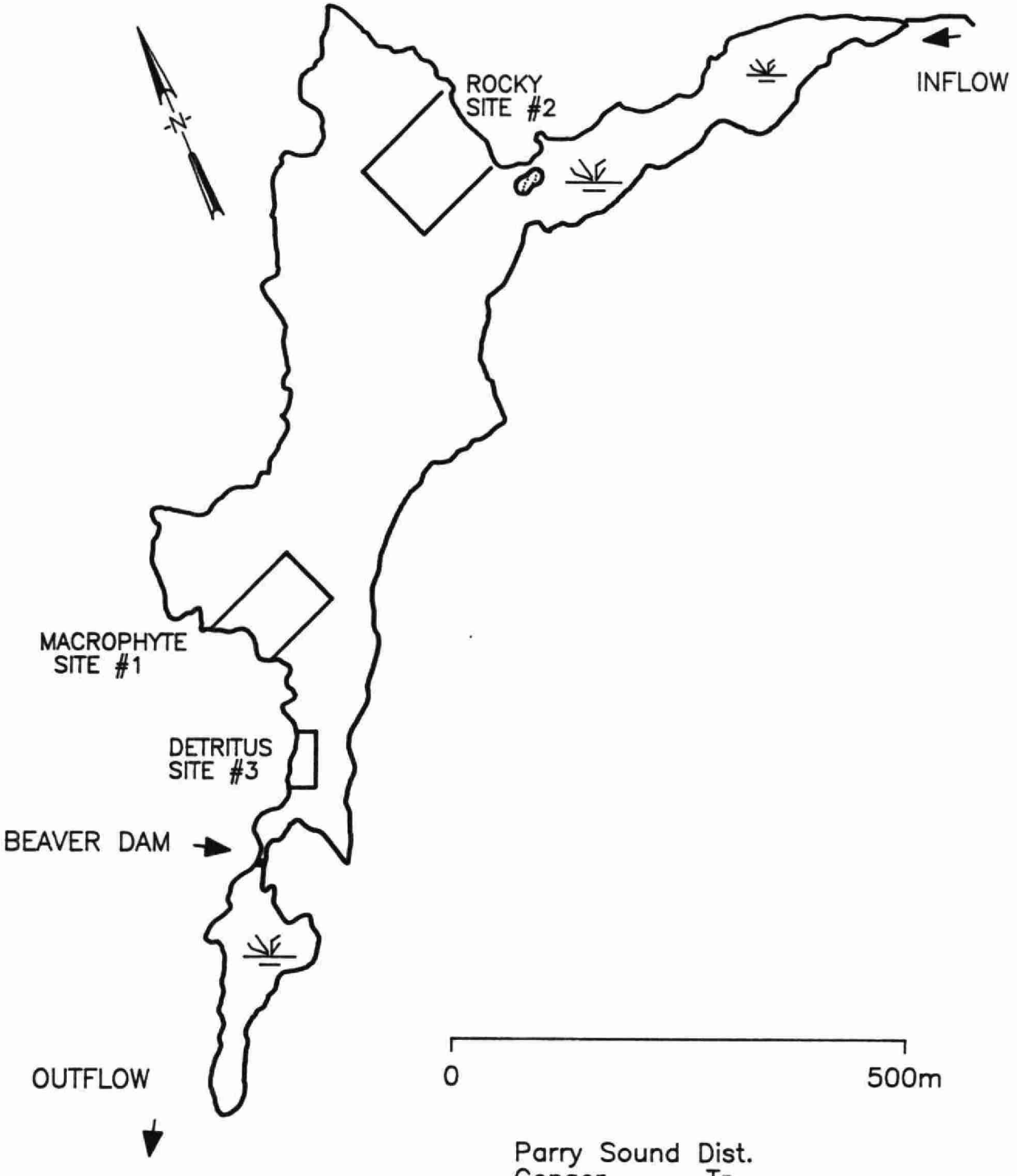
Skidway Lake



Area (ha)	Volume (m3*105)	Mean Depth (m)	Maximum Depth (m)	Shoreline Length (km)
18.48	5.35	2.89	7.80	2.84

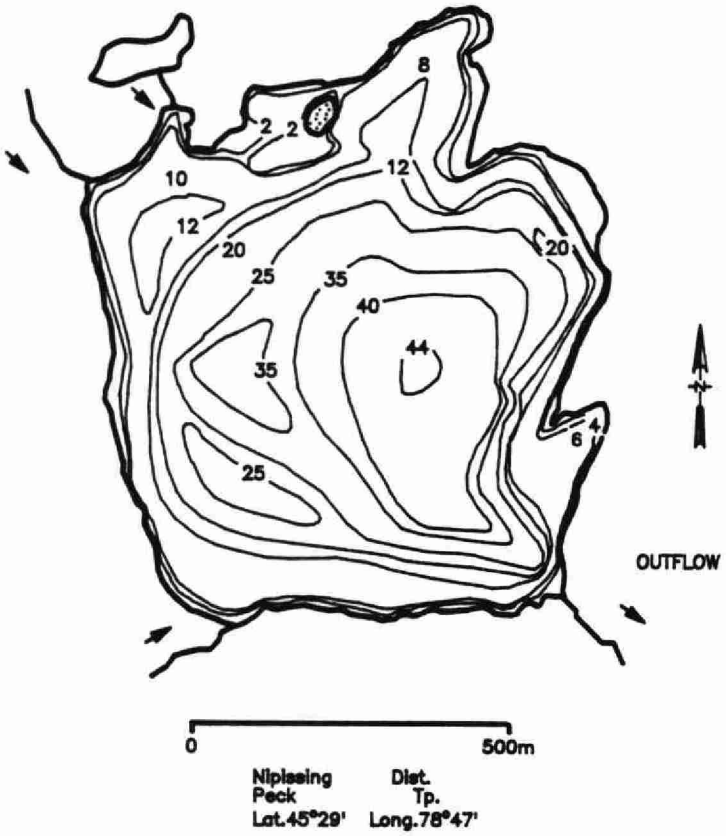
Contour Depth (m)	Contour Area (ha)	Stratum Volume (m3*105)
0	18.48	
		2.86
2	11.75	
		1.89
4	6.09	
		0.50
6	1.06	
		0.10
8	0	

Skidway Lake – trap site locations



Parry Sound Dist.
Conger Tp.
Lat.45°12' Long.79°52'

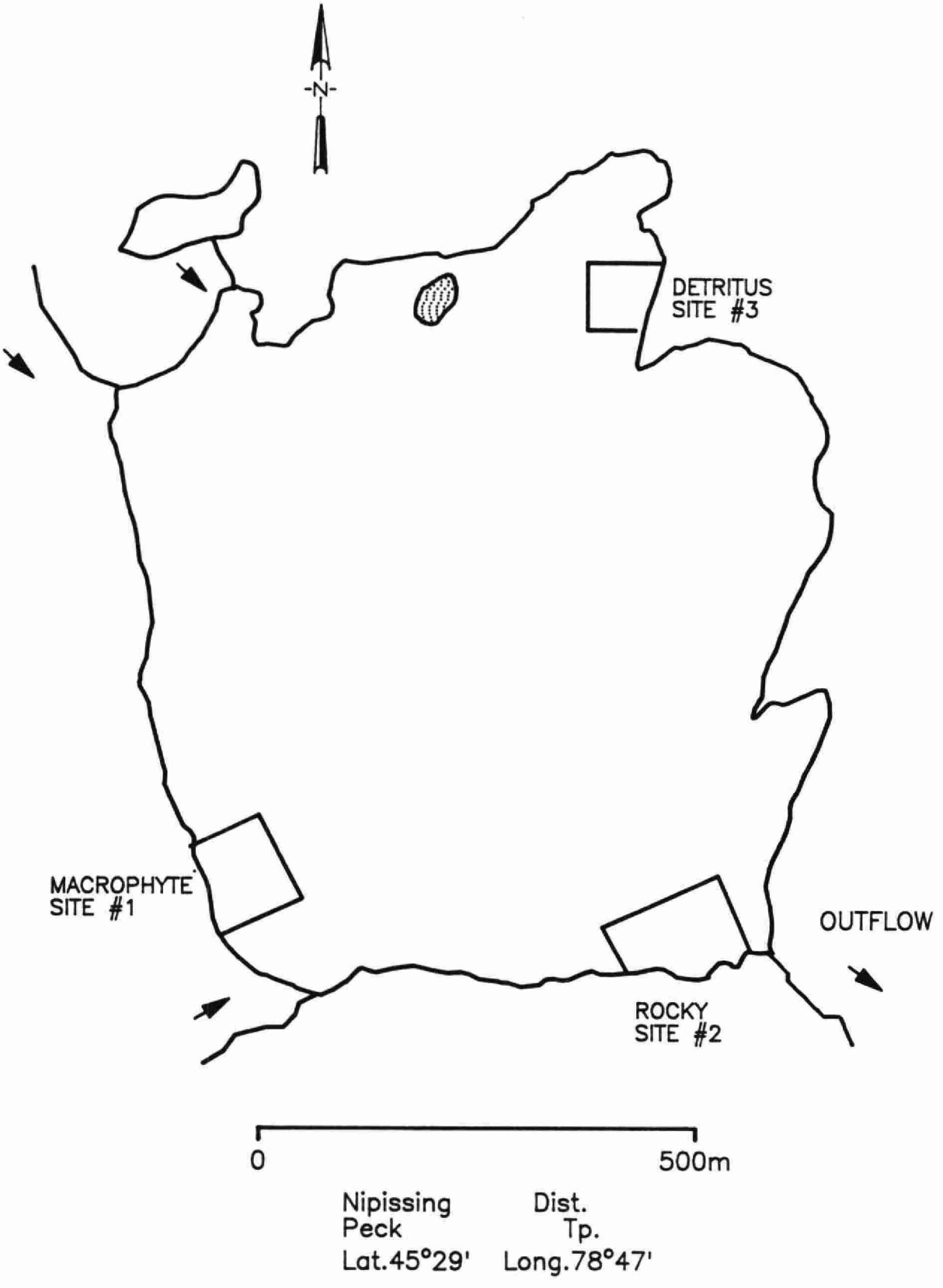
Westward Lake



Area (ha)	Volume (m3*105)	Mean Depth (m)	Maximum Depth (m)	Shoreline Length (km)
63.3	129.5	20.5	44.0	3.52

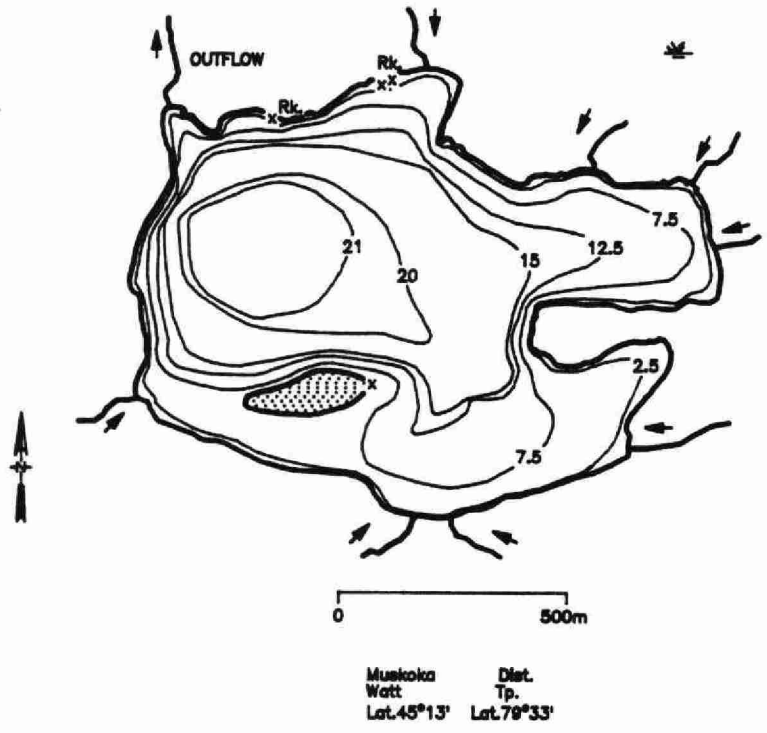
Contour Depth (m)	Contour Area (ha)	Stratum Volume (m3*105)
0	63.3	
		12.1
2	58.4	
		11.3
4	55.0	
		10.8
6	53.1	
		10.3
8	49.7	
		9.57
10	46.1	
		8.65
12	40.5	
		14.9
16	34.0	
		12.9
20	30.6	
		13.8
25	24.8	
		10.9
30	18.8	
		7.97
35	13.2	
		5.04
40	7.22	
		1.24
44	0.383	

Westward Lake – trap site locations



Nipissing Dist.
Peck Tp.
Lat.45°29' Long.78°47'

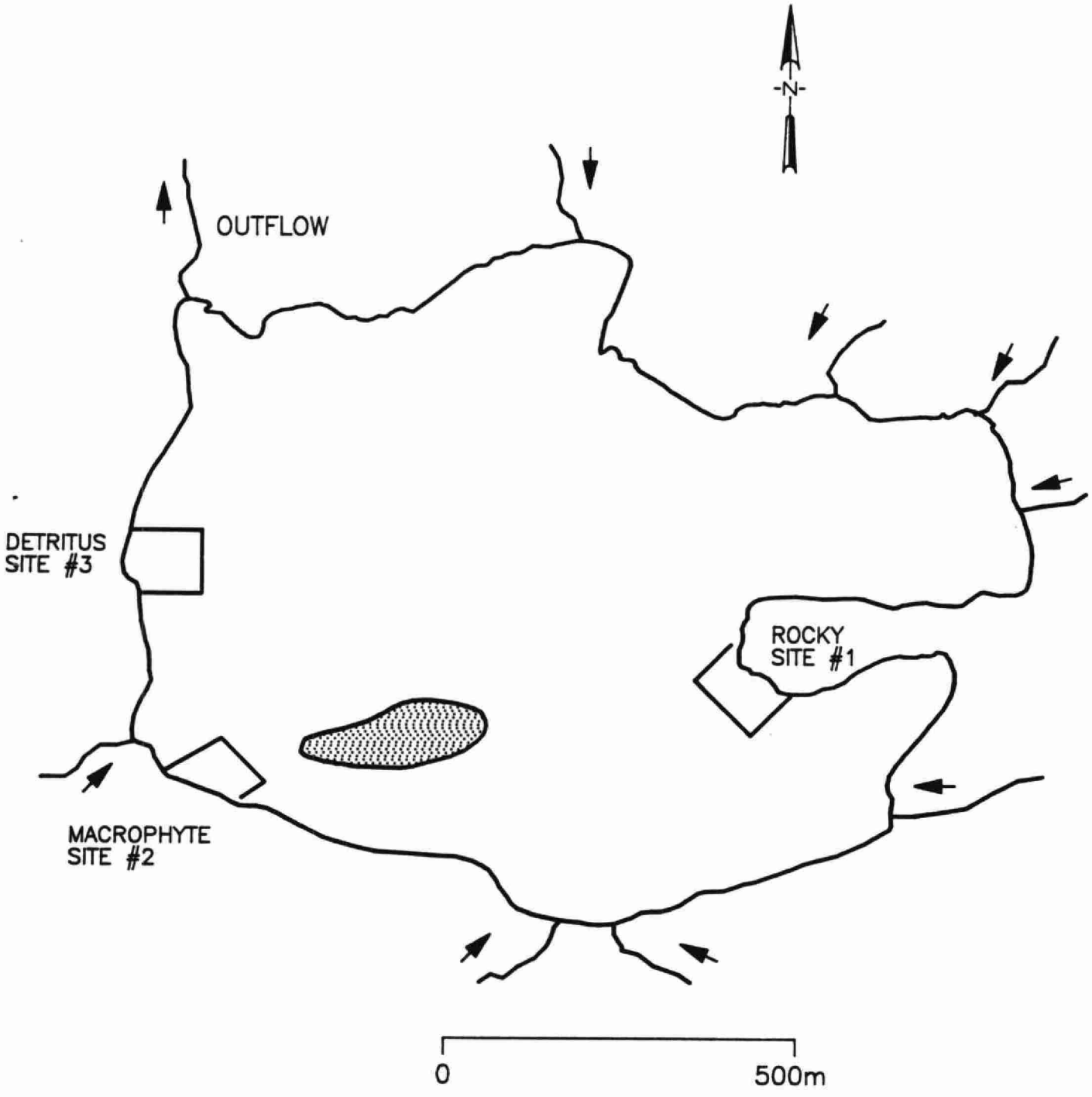
Young Lake



Area (ha)	Volume (m3*105)	Mean Depth (m)	Maximum Depth (m)	Shoreline Length (km)
105.9	127.4	12.03	21.1	5.40

Contour Depth (m)	Contour Area (ha)	Stratum Volume (m3*105)
0	105.91	
		20.46
2	98.72	
		18.97
4	90.82	
		17.27
6	80.82	
		15.07
8	70.06	
		13.07
10	60.75	
		11.34
12	52.72	
		9.814
14	45.60	
		8.413
16	38.13	
		6.812
18	29.21	
		4.721
20	18.42	
		1.457
21.1	0	

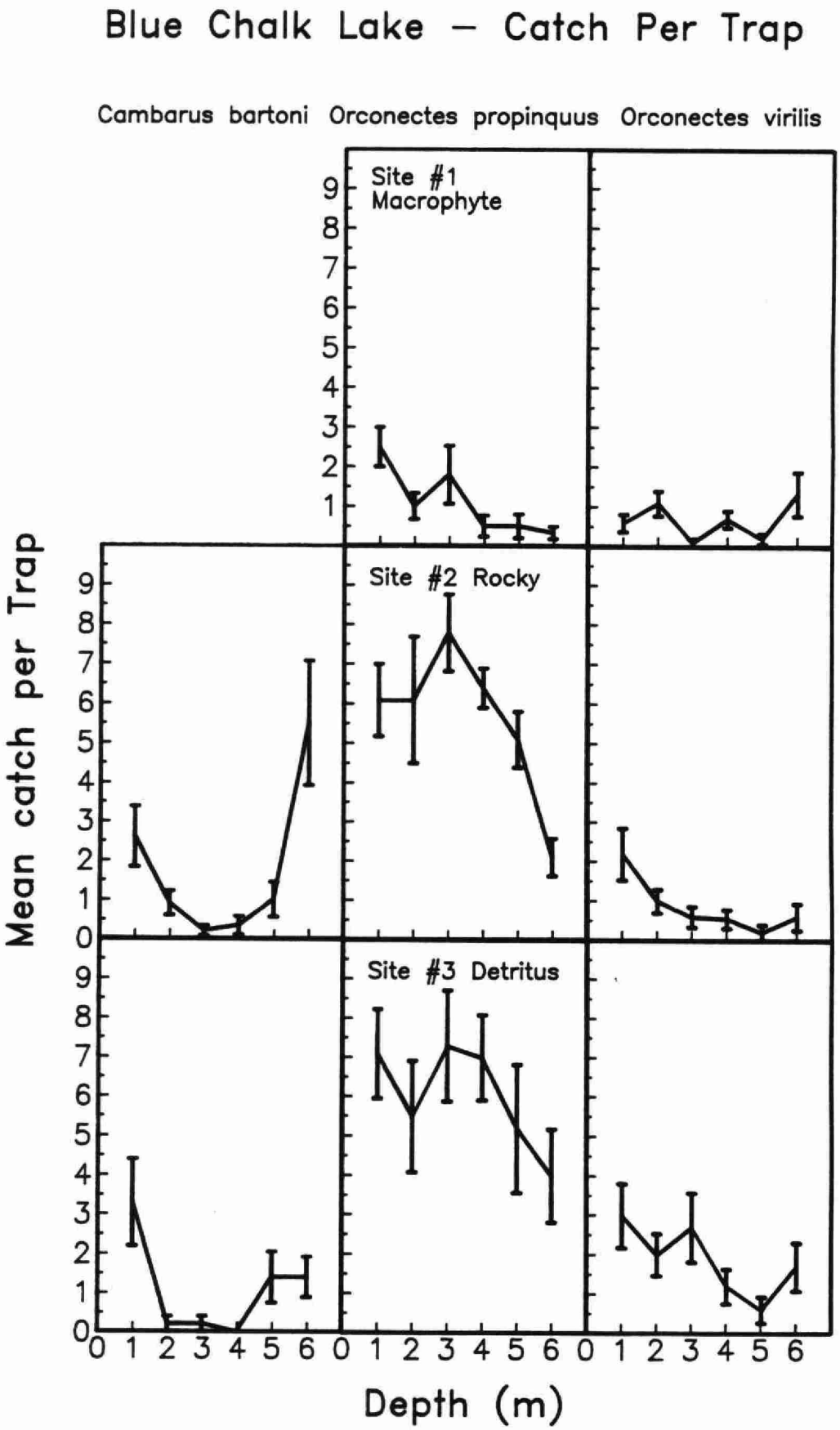
Young Lake – trap site locations

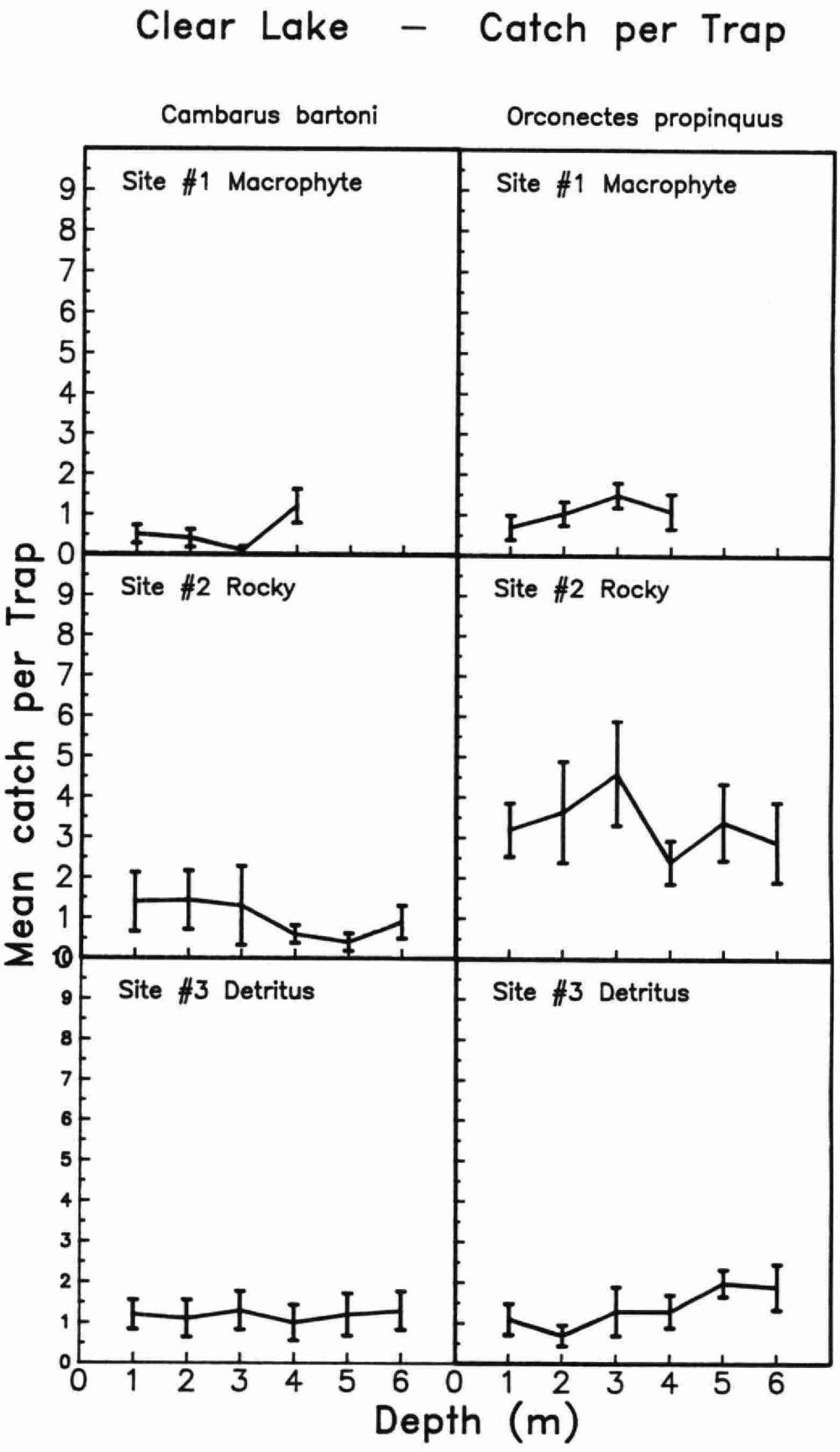


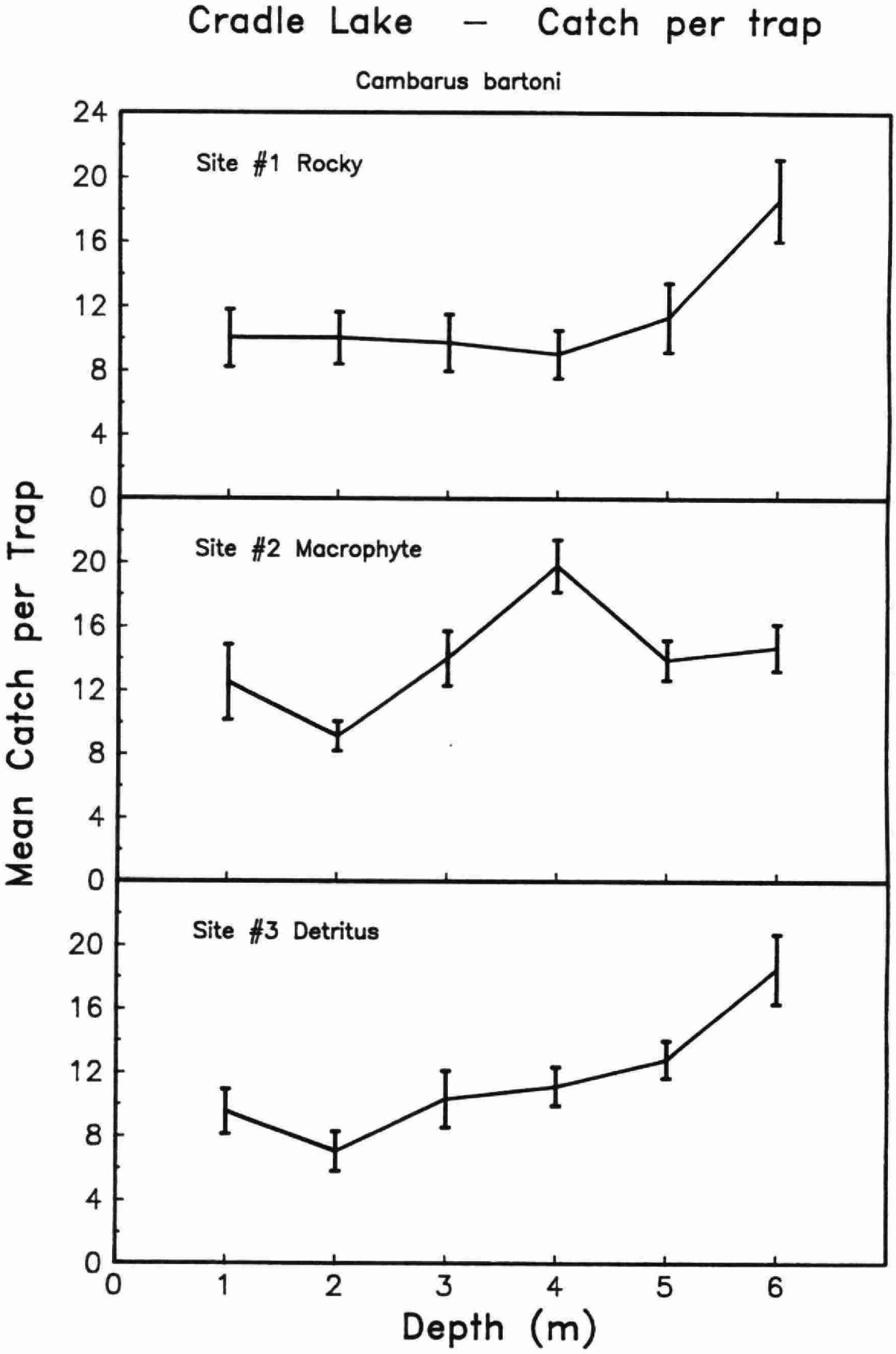
Muskoka Watt Lat.45°13'

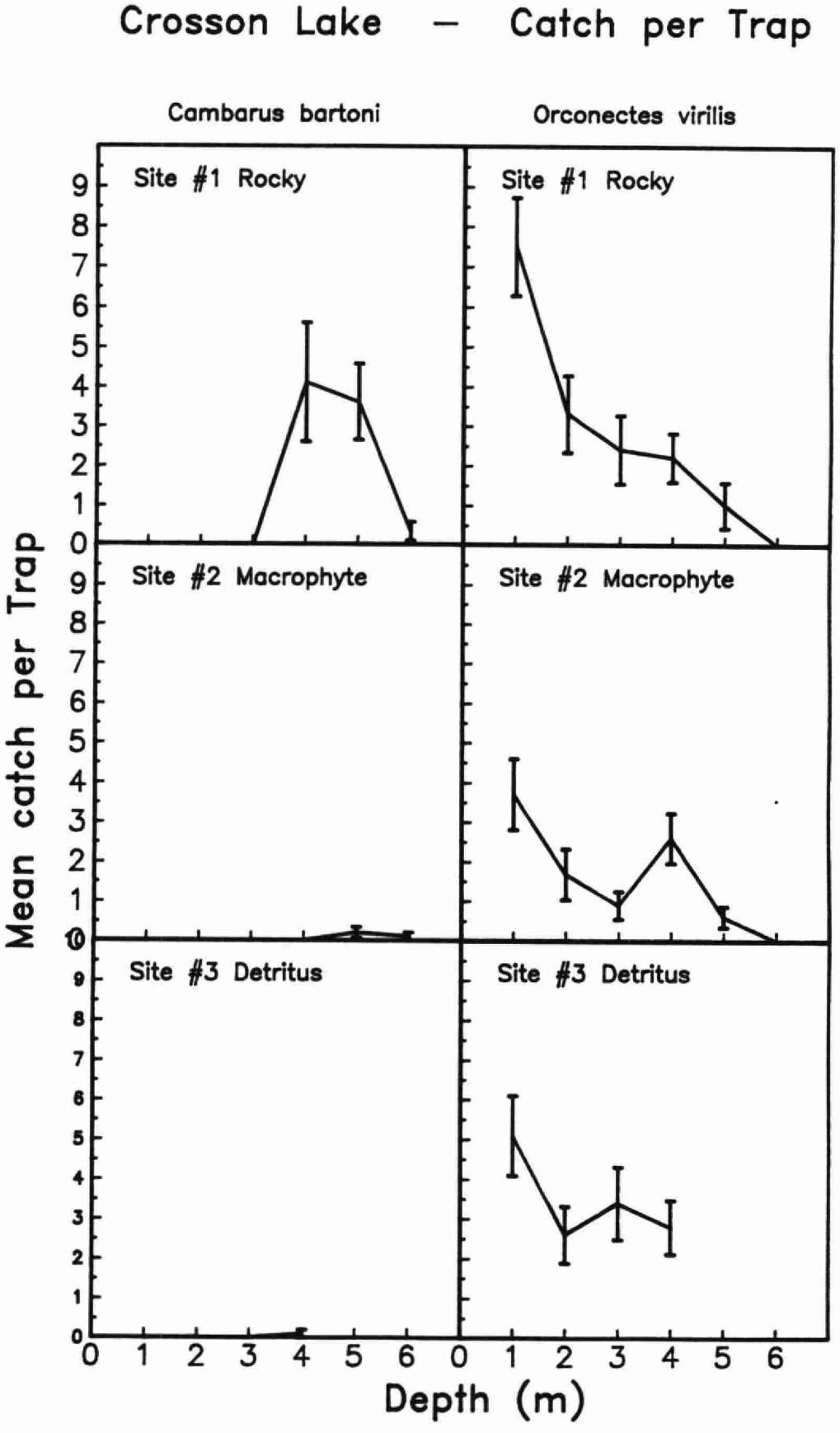
Dist. Tp. Lat.79°33'

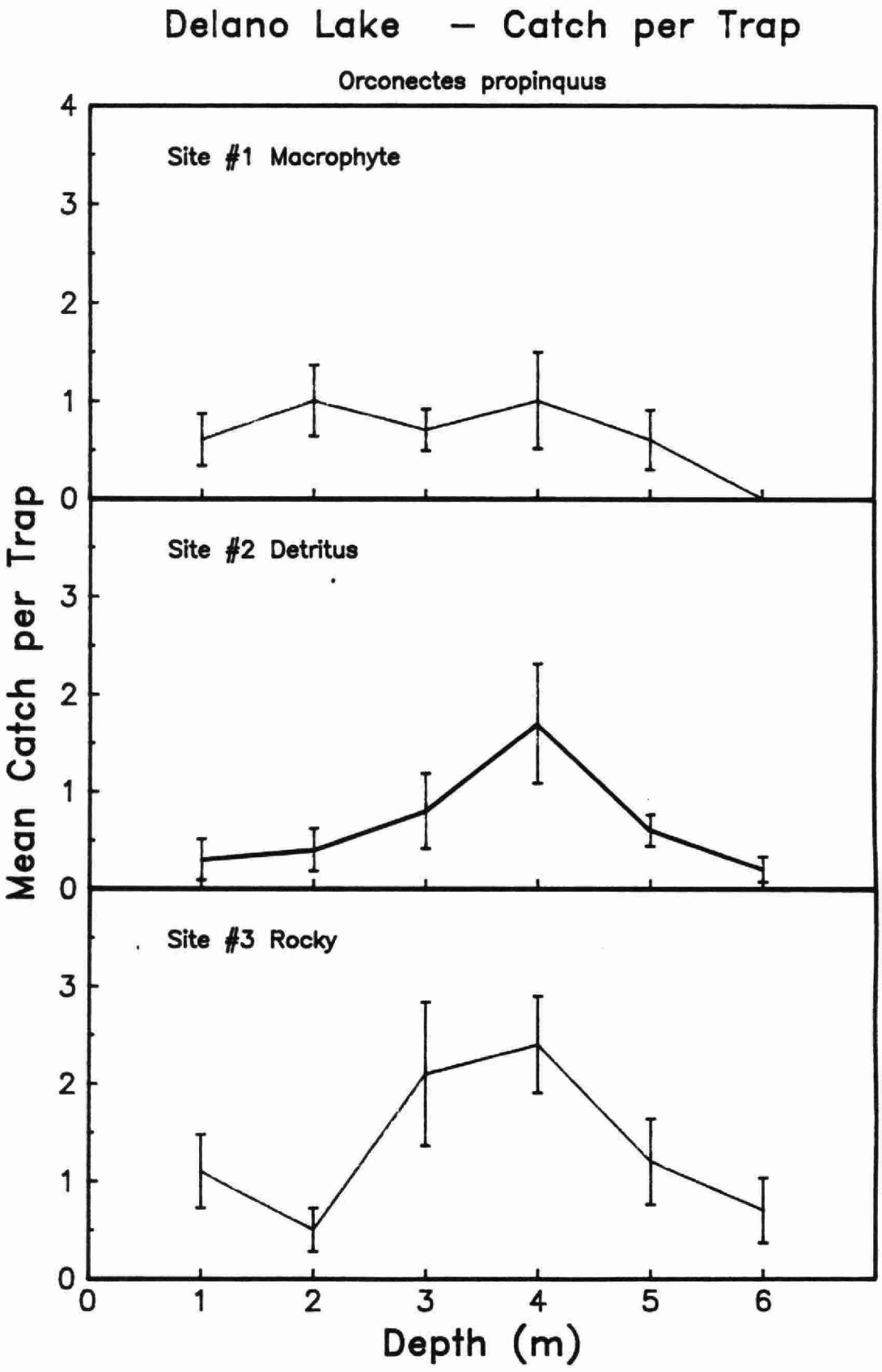
Appendix 2: Catch per Tráp Data

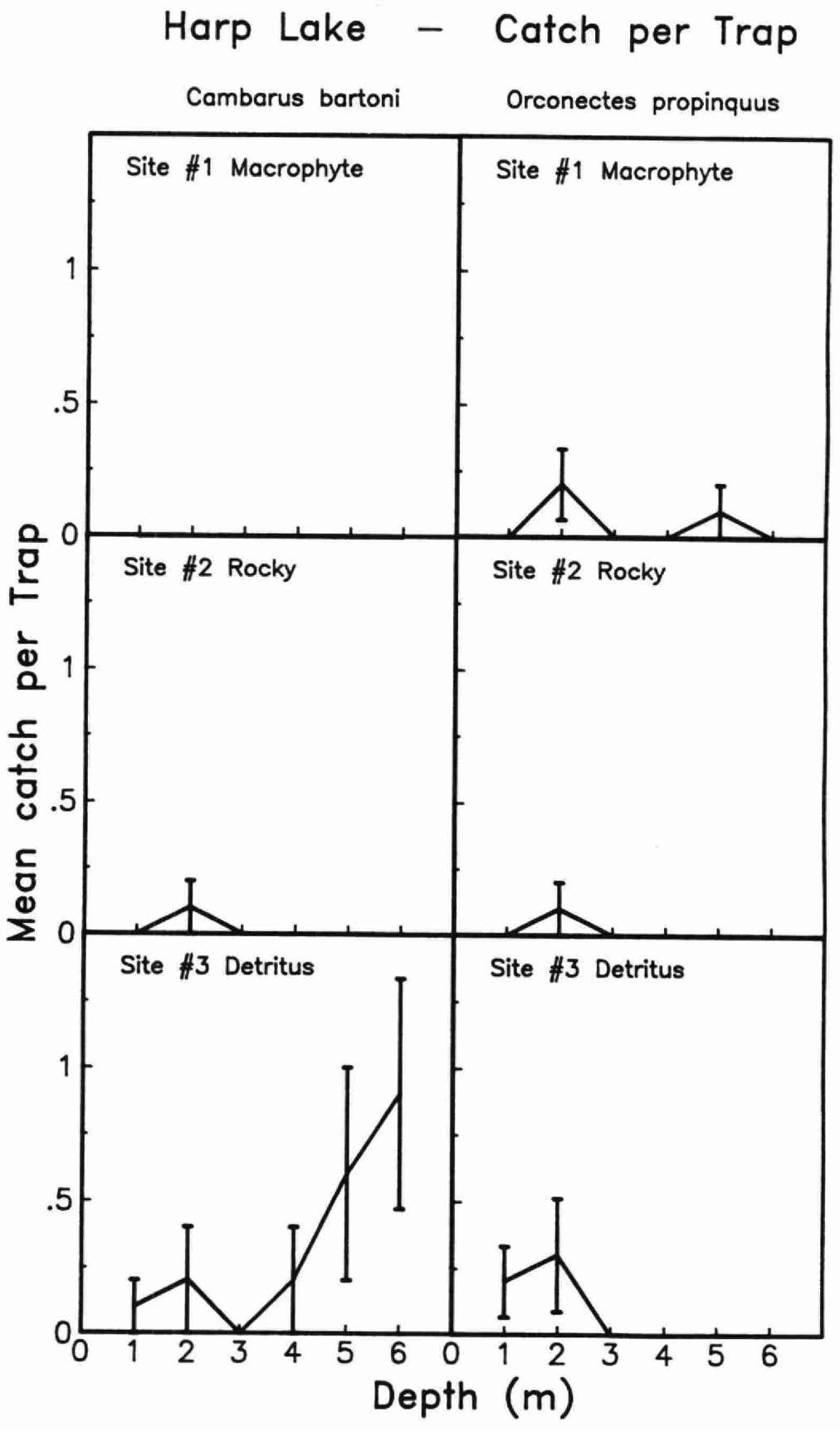



Clear Lake – Catch per Trap
Cambarus bartoni
Orconectes propinquus
Site #1 Macrophyte
Site #1 Macrophyte
Site #2 Rocky
Site #2 Rocky
Site #3 Detritus
Site #3 Detritus
Mean catch per Trap
Depth (m)
0 1 2 3 4 5 6

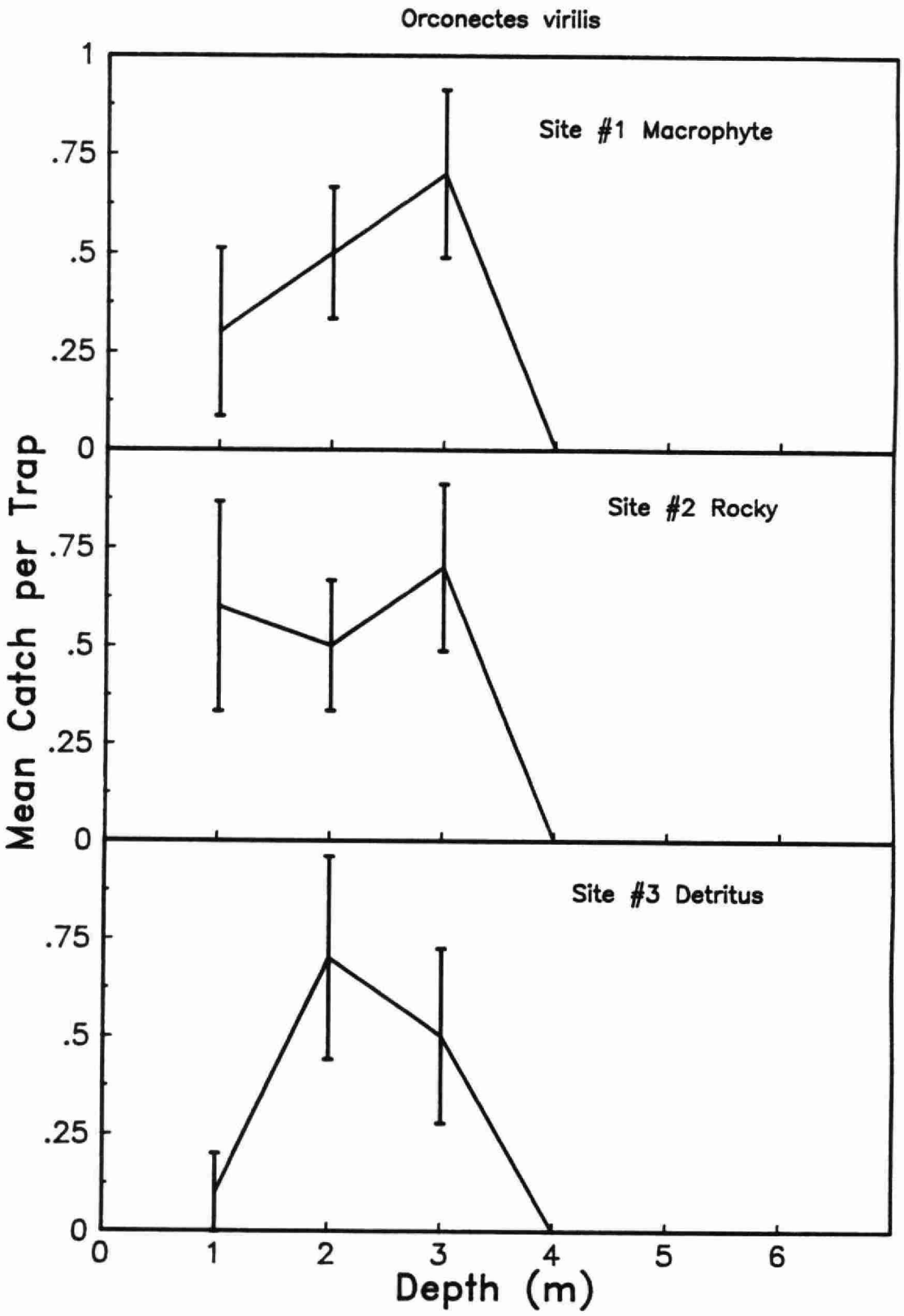

Cradle Lake — Catch per trap
Cambarus bartoni
Site #1 Rocky
Site #2 Macrophyte
Site #3 Detritus
Mean Catch per Trap
Depth (m)
0
4
8
12
16
20
24
1
2
3
4
5
6

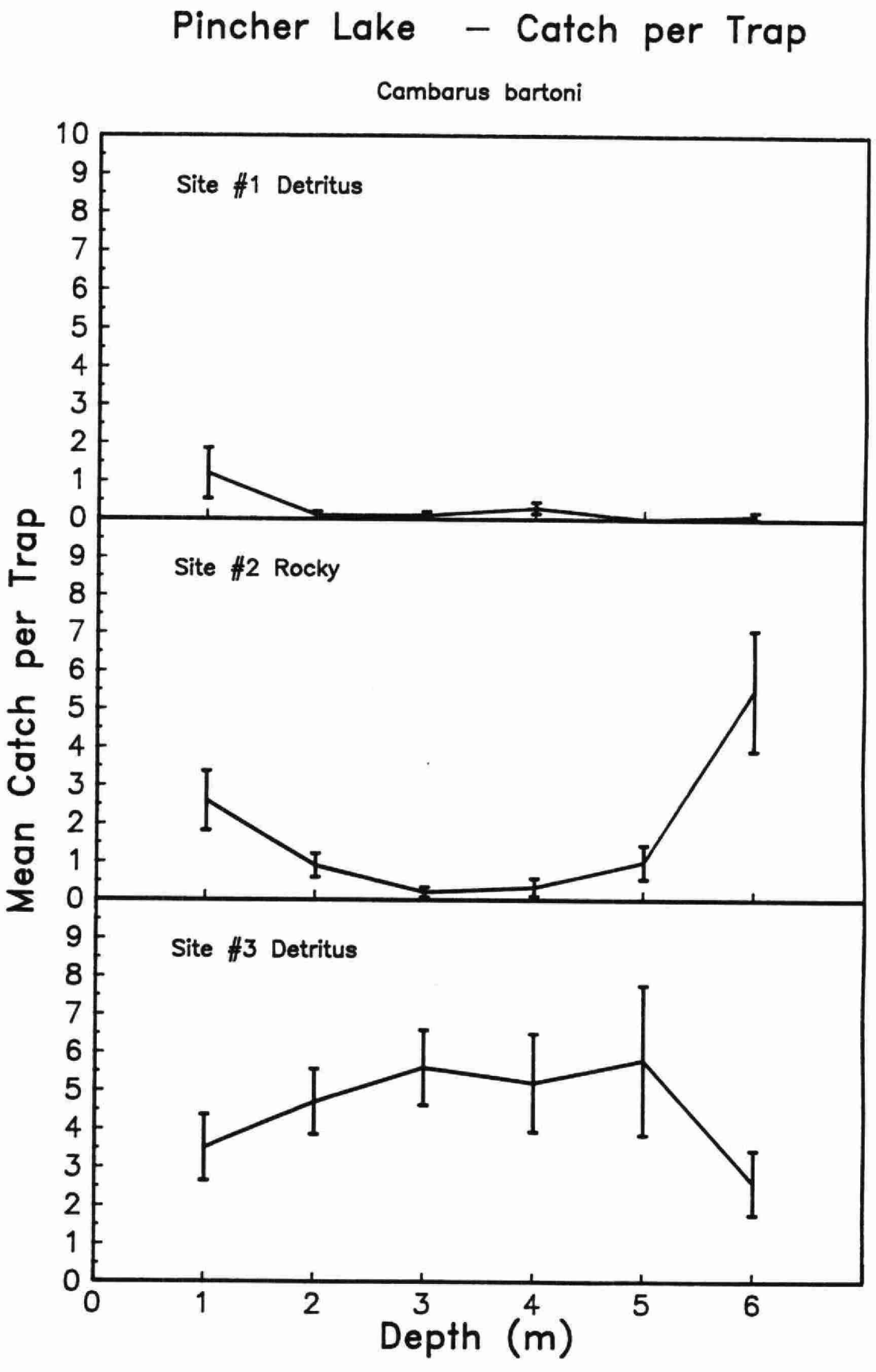

Crosson Lake — Catch per Trap
Cambarus bartoni
Orconectes virilis
Site #1 Rocky
Site #1 Rocky
Site #2 Macrophyte
Site #2 Macrophyte
Site #3 Detritus
Site #3 Detritus
Mean catch per Trap
Depth (m)
0 1 2 3 4 5 6 7 8 9
0 1 2 3 4 5 6

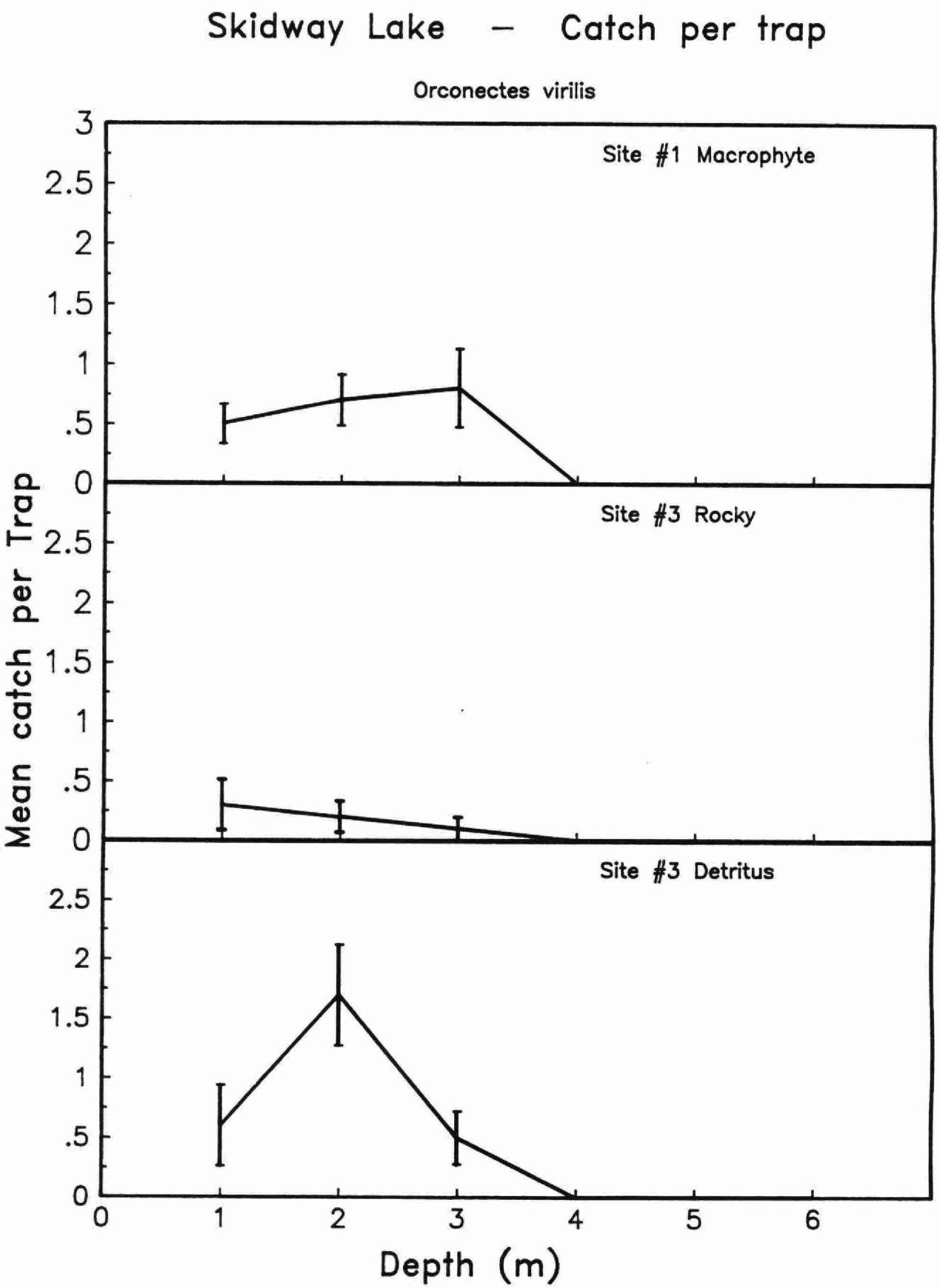

Delano Lake – Catch per Trap
Orconectes propinquus
Site #1 Macrophyte
Site #2 Detritus
Site #3 Rocky
Mean Catch per Trap
Depth (m)
0
1
2
3
4
5
6

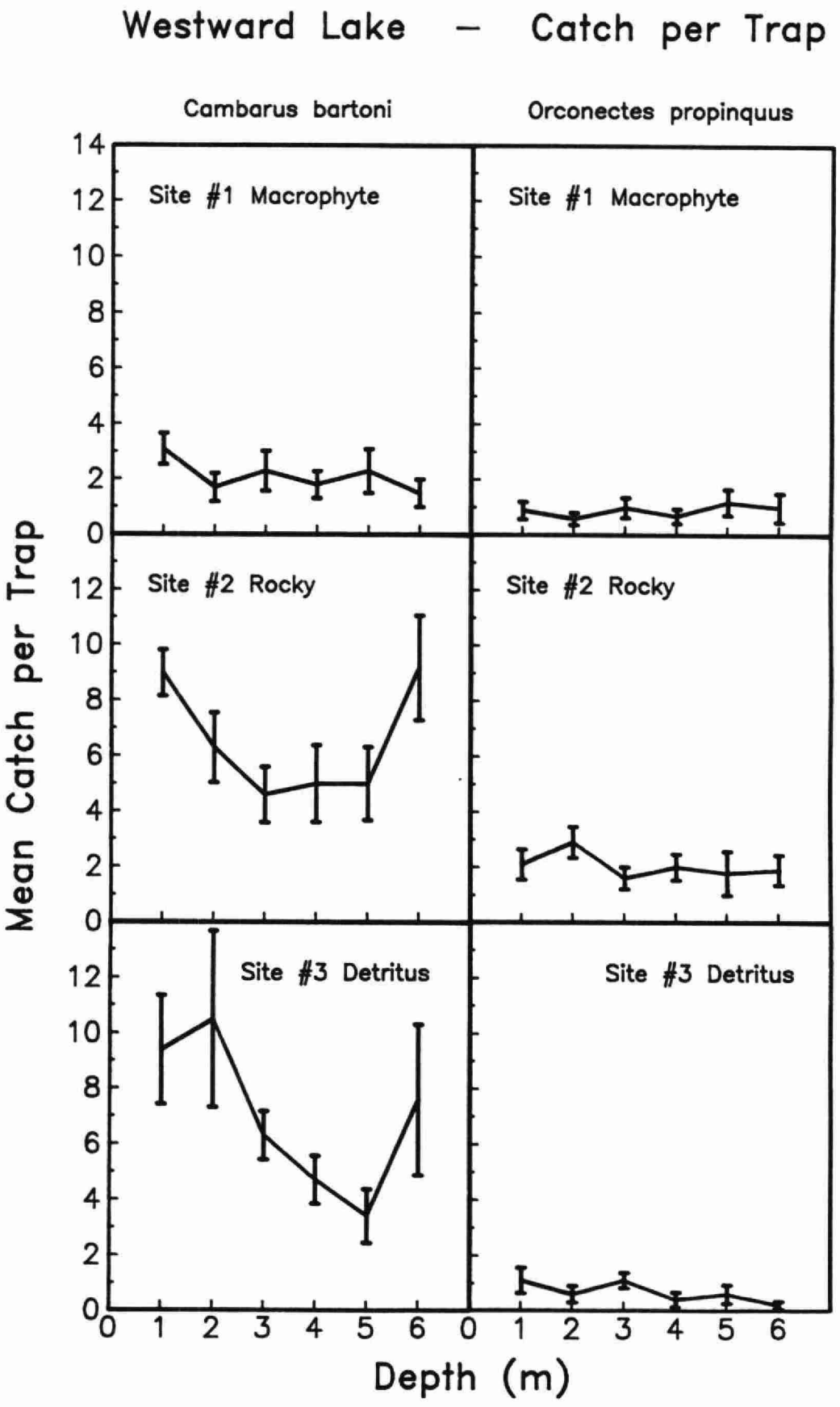

Harp Lake – Catch per Trap
Cambarus bartoni
Orconectes propinquus
Site #1 Macrophyte
Site #1 Macrophyte
Site #2 Rocky
Site #2 Rocky
Site #3 Detritus
Site #3 Detritus
Mean catch per Trap
0
.5
1
0 1 2 3 4 5 6
Depth (m)

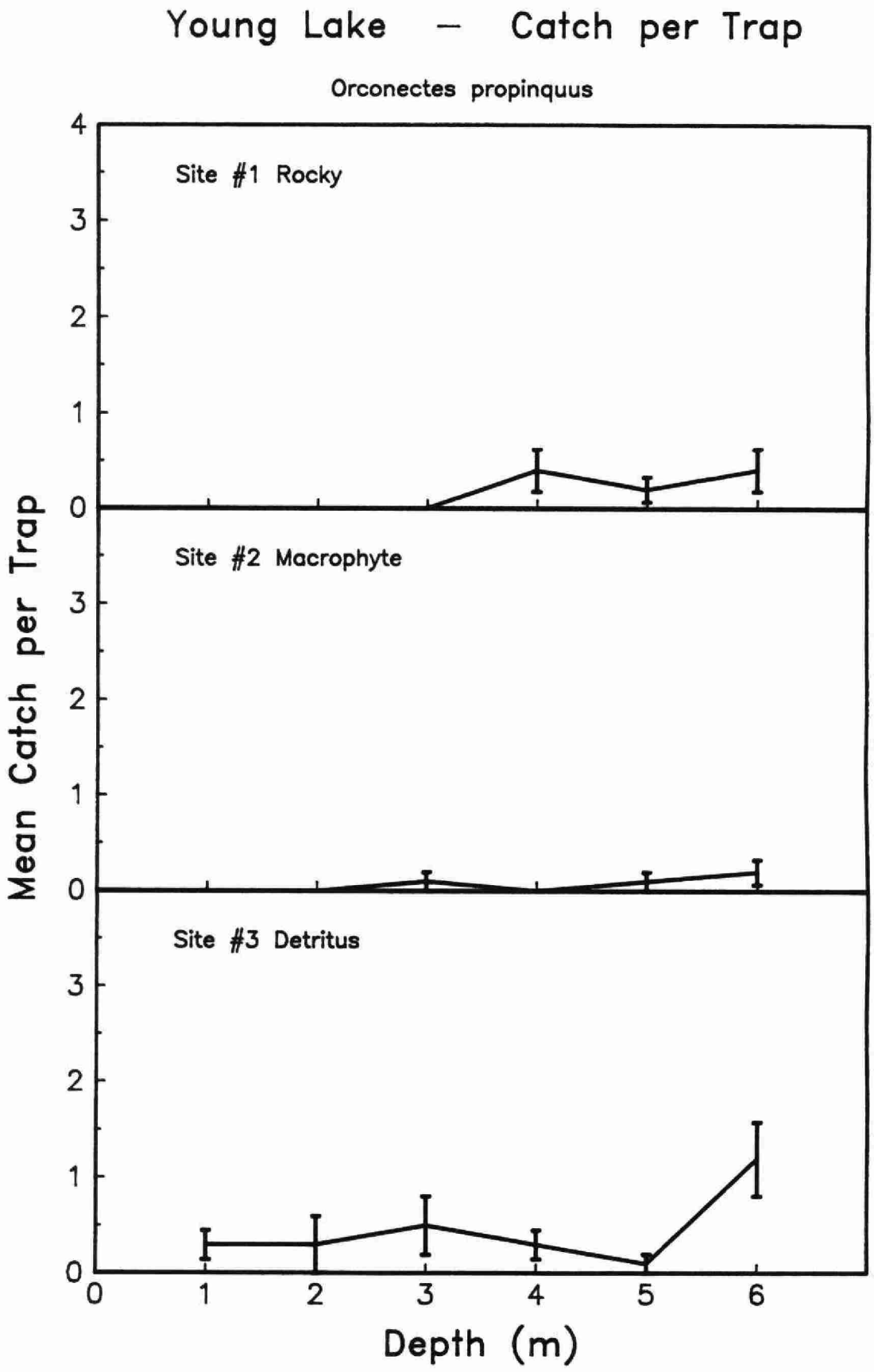
Hamer Lake – Catch per Trap



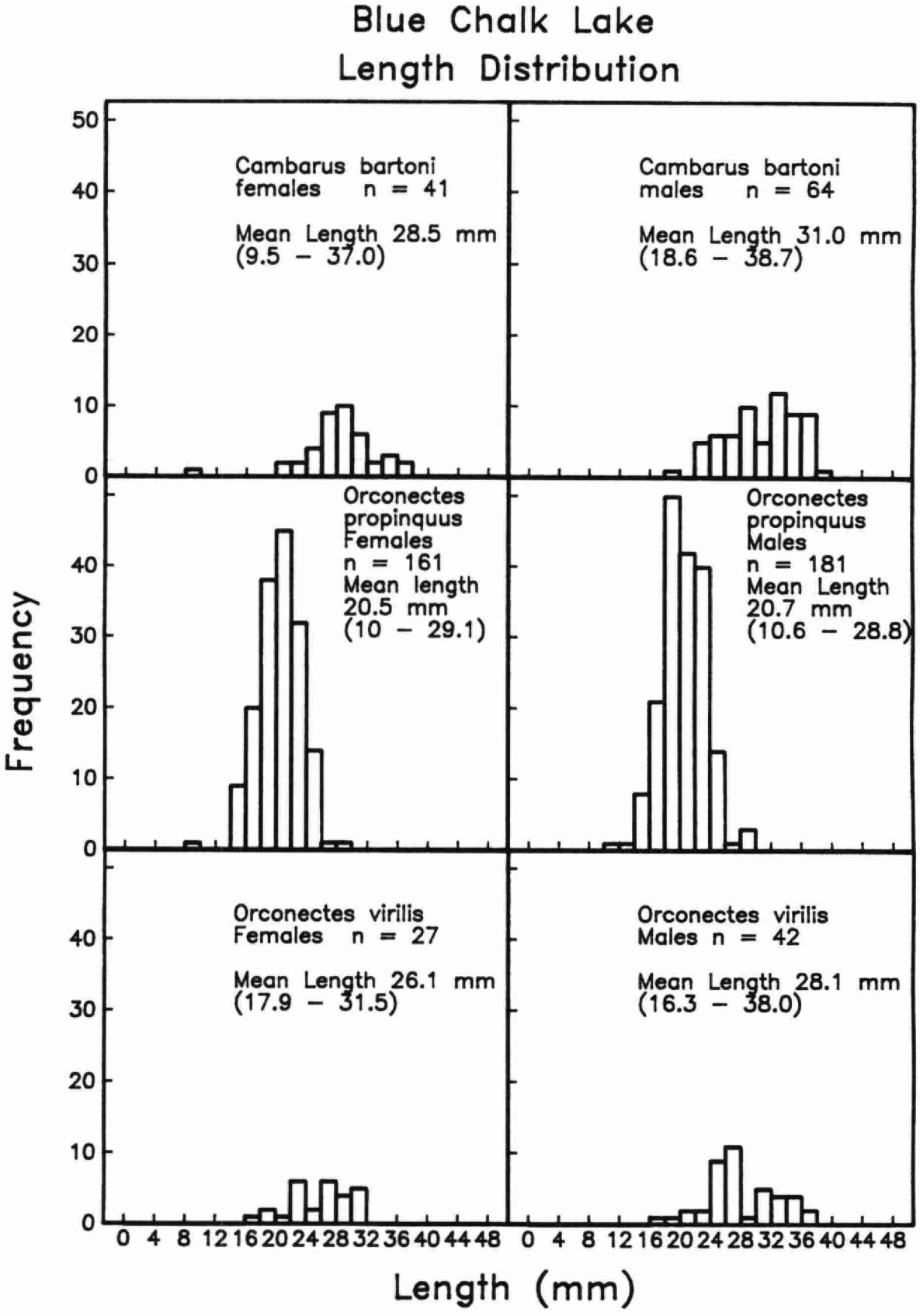

Pincher Lake — Catch per Trap
Cambarus bartoni
Site #1 Detritus
Site #2 Rocky
Site #3 Detritus
Mean Catch per Trap
Depth (m)
0
1
2
3
4
5
6
7
8
9
10

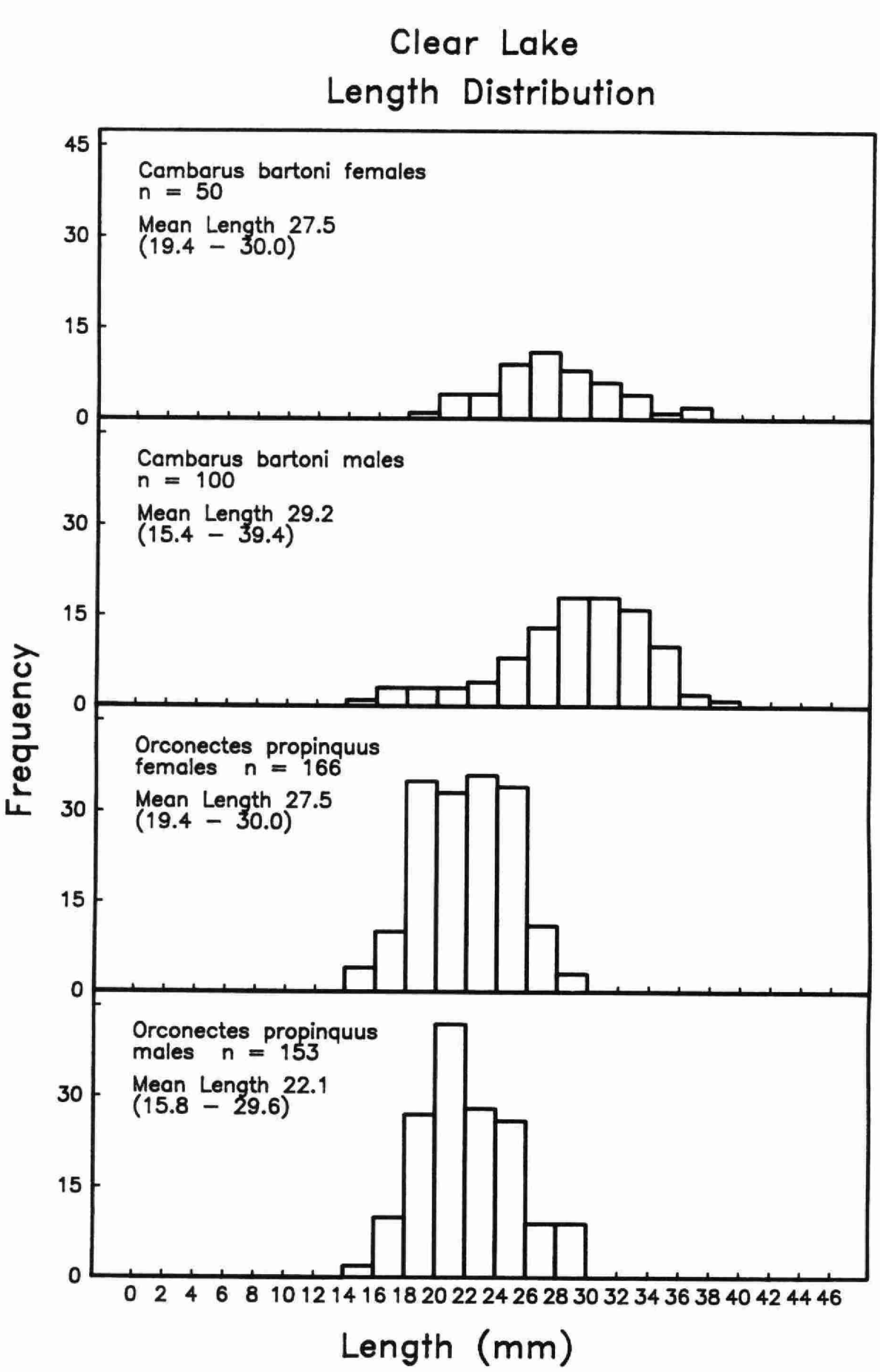

Skidway Lake – Catch per trap
Orconectes virilis
Site #1 Macrophyte
Site #3 Rocky
Site #3 Detritus
Mean catch per Trap
Depth (m)
0
.5
1
1.5
2
2.5
3
0
1
2
3
4
5
6

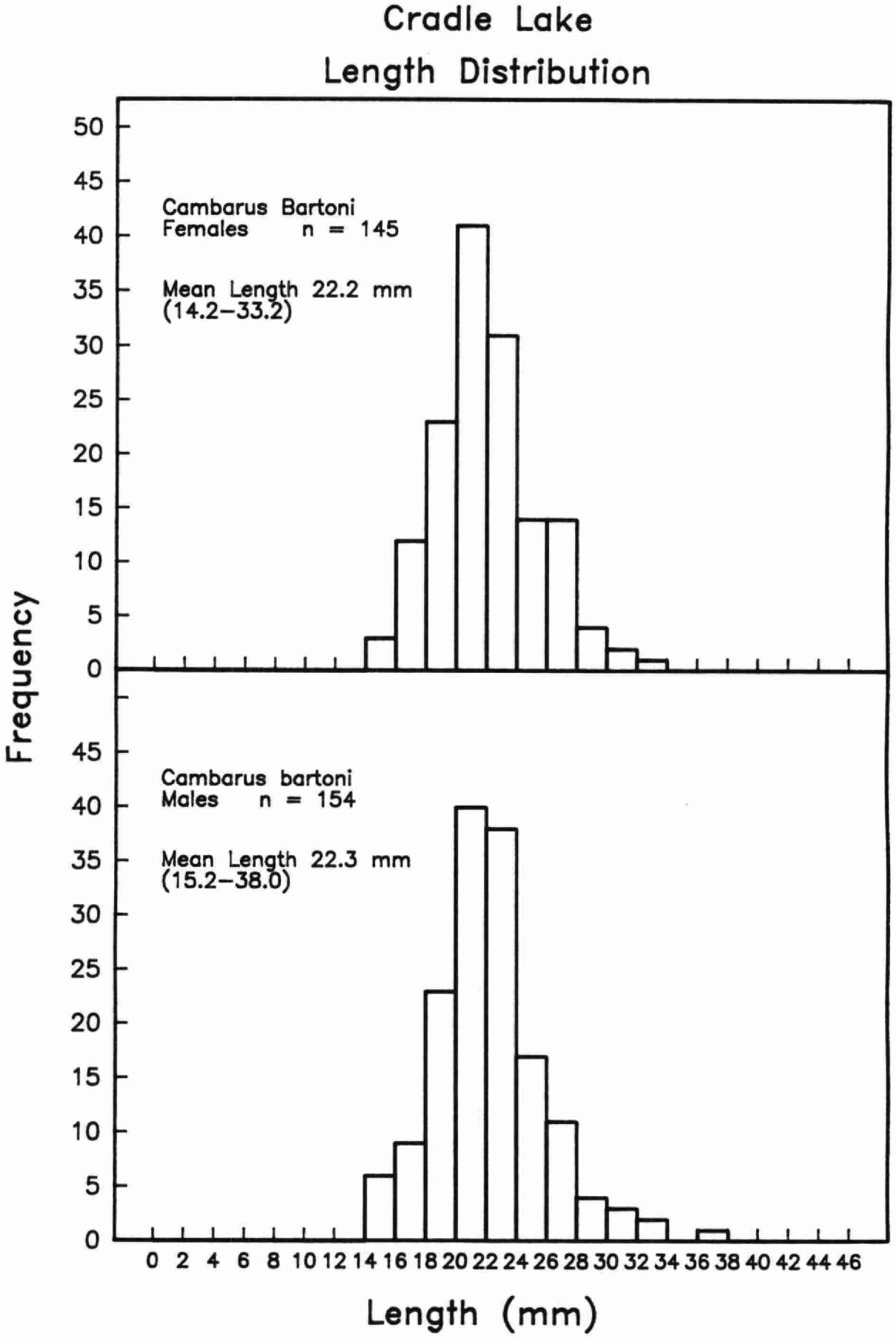

Westward Lake — Catch per Trap
Cambarus bartoni
Orconectes propinquus
Site #1 Macrophyte
Site #1 Macrophyte
Site #2 Rocky
Site #2 Rocky
Site #3 Detritus
Site #3 Detritus
Mean Catch per Trap
Depth (m)
0
2
4
6
8
10
12
14
1
3
5

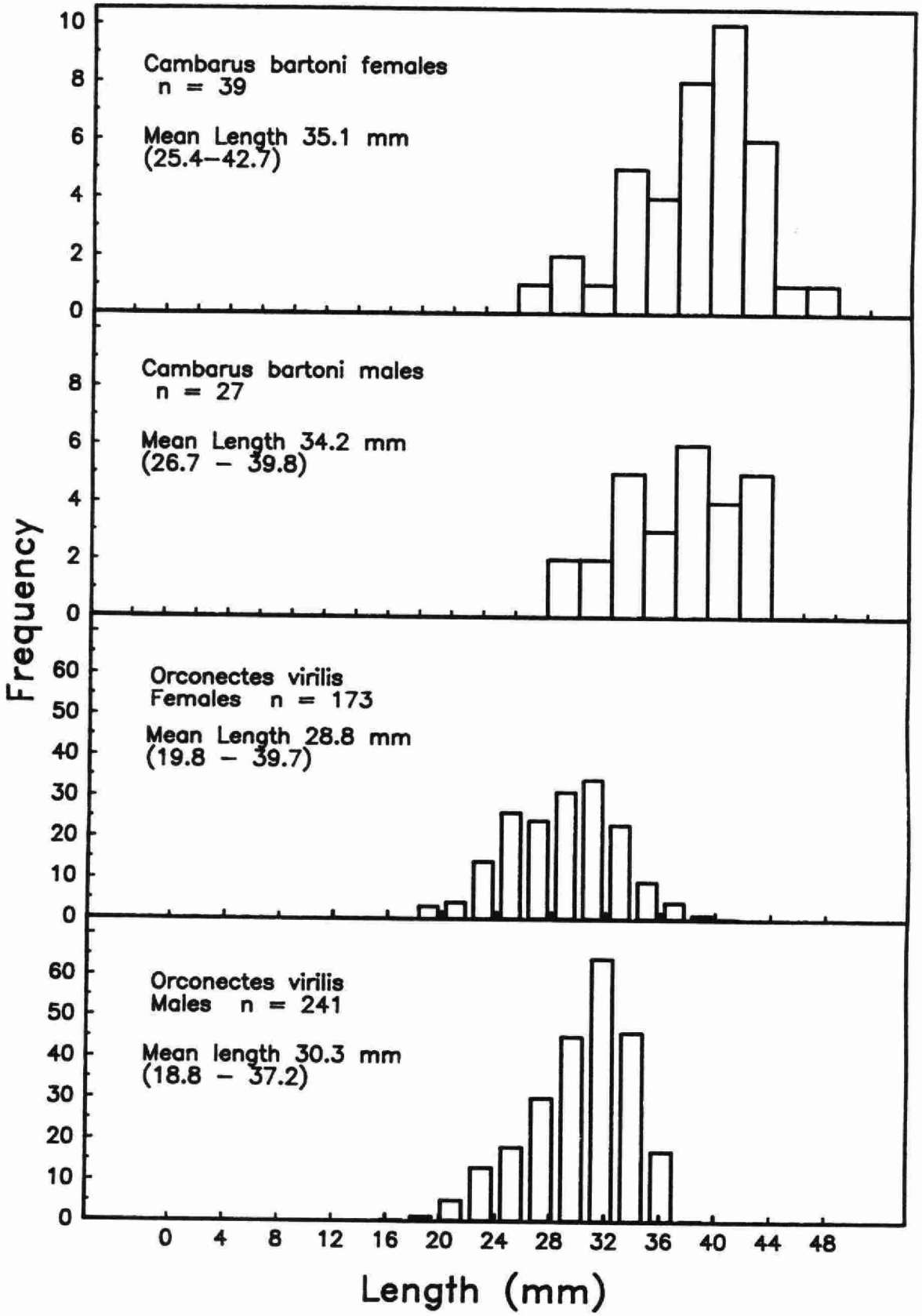

Young Lake — Catch per Trap
Orconectes propinquus
Site #1 Rocky
Site #2 Macrophyte
Site #3 Detritus
Mean Catch per Trap
Depth (m)
0
1
2
3
4
5
6

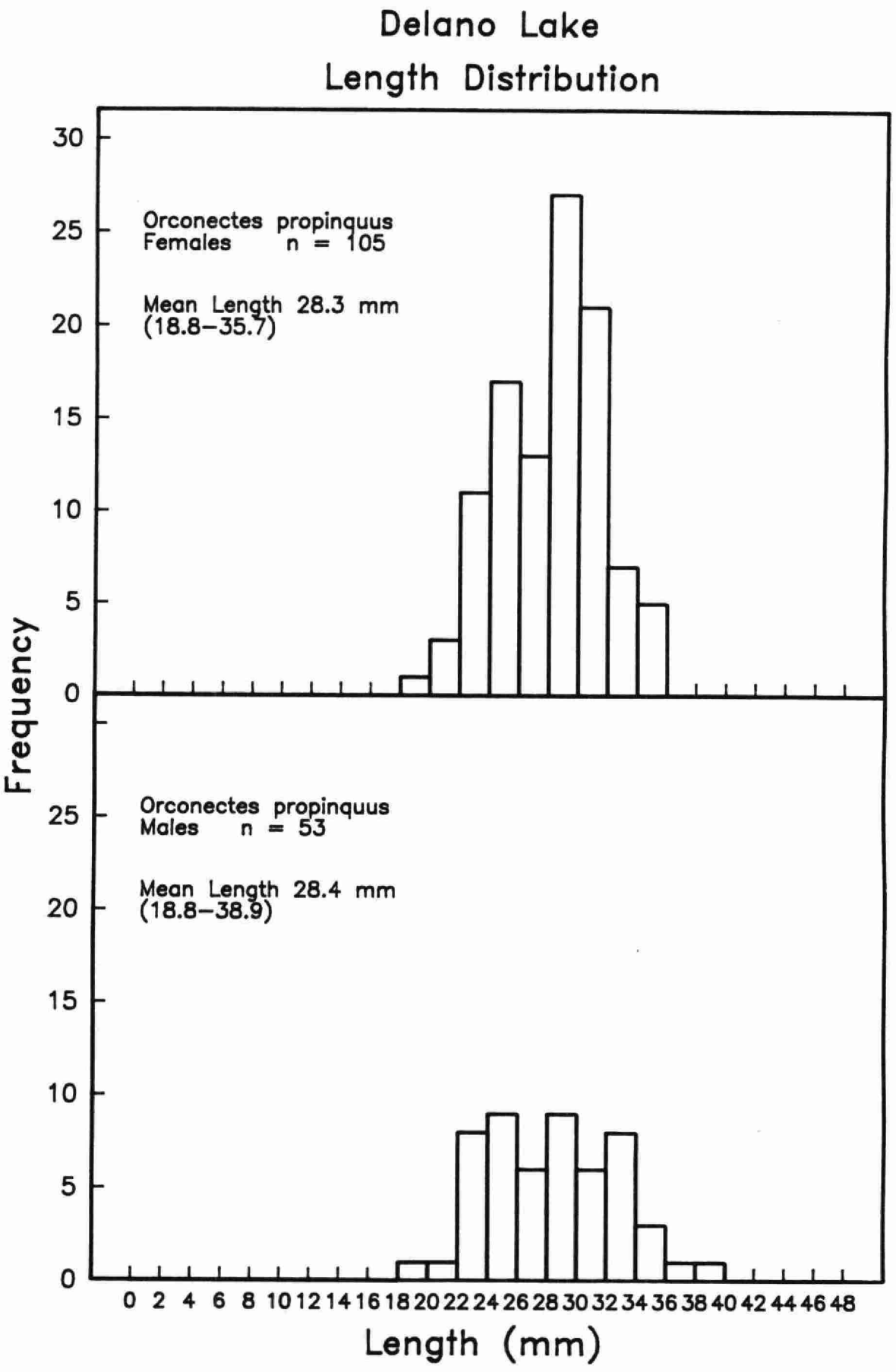
Appendix 3: Length - Frequency Histograms



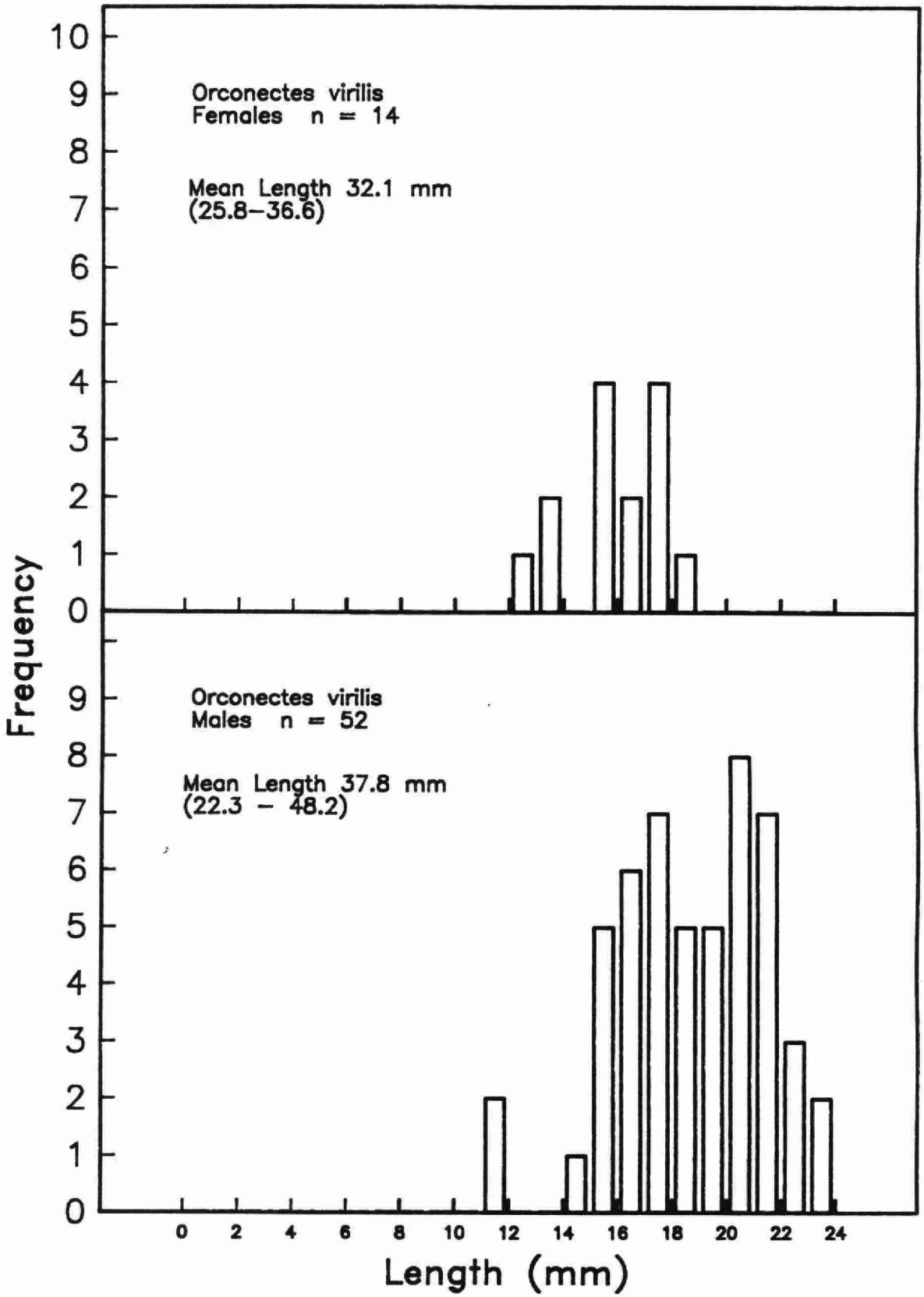

Clear Lake
Length Distribution
Cambarus bartoni females
n = 50
Mean Length 27.5
(19.4 – 30.0)
Cambarus bartoni males
n = 100
Mean Length 29.2
(15.4 – 39.4)
Orconectes propinquus
females n = 166
Mean Length 27.5
(19.4 – 30.0)
Orconectes propinquus
males n = 153
Mean Length 22.1
(15.8 – 29.6)
Frequency
0
15
30
45
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46
Length (mm)


Cradle Lake
Length Distribution
Cambarus Bartoni
Females n = 145
Mean Length 22.2 mm
(14.2–33.2)
Cambarus bartoni
Males n = 154
Mean Length 22.3 mm
(15.2–38.0)
Frequency
0 5 10 15 20 25 30 35 40 45 50
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46
Length (mm)

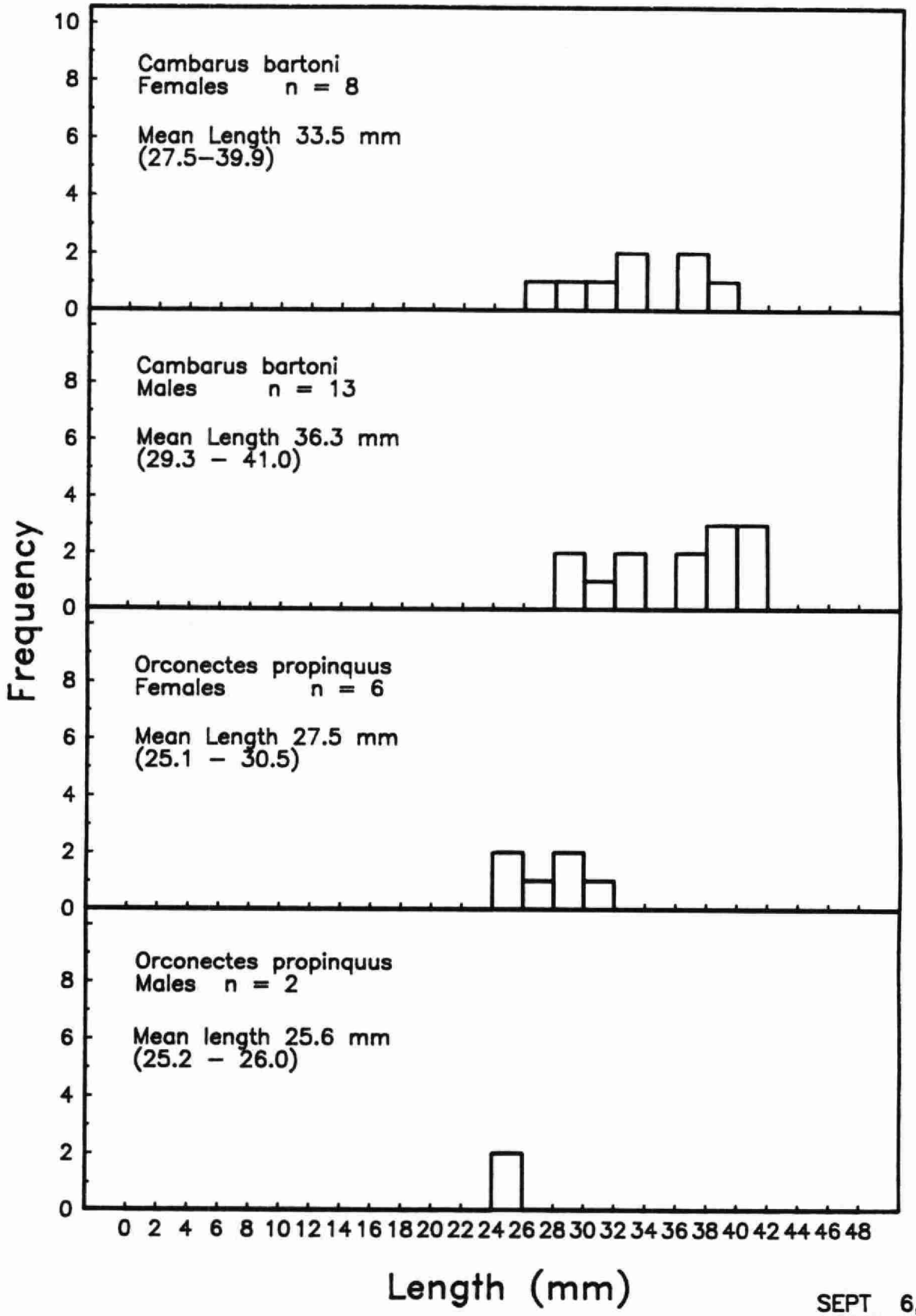

Crosson Lake
Length Distribution
Cambarus bartoni females
n = 39
Mean Length 35.1 mm
(25.4–42.7)
Cambarus bartoni males
n = 27
Mean Length 34.2 mm
(26.7 – 39.8)
Orconectes virilis
Females n = 173
Mean Length 28.8 mm
(19.8 – 39.7)
Orconectes virilis
Males n = 241
Mean length 30.3 mm
(18.8 – 37.2)
Frequency
Length (mm)


Delano Lake
Length Distribution
Orconectes propinquus
Females n = 105
Mean Length 28.3 mm
(18.8–35.7)
Orconectes propinquus
Males n = 53
Mean Length 28.4 mm
(18.8–38.9)
Frequency
Length (mm)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
0 5 10 15 20 25 30

Hamer Lake
Length Distribution



Harp Lake
Length Distribution



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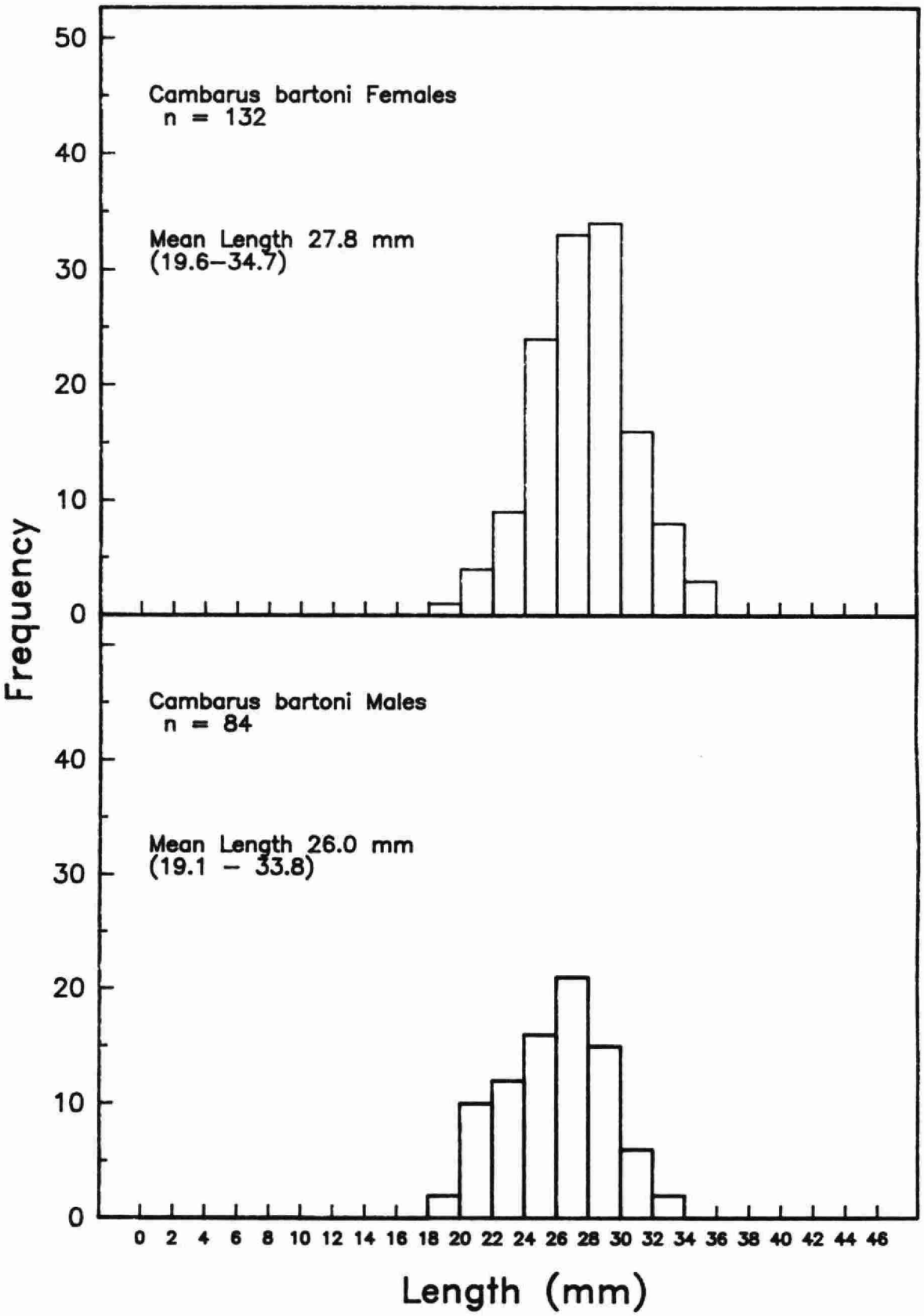
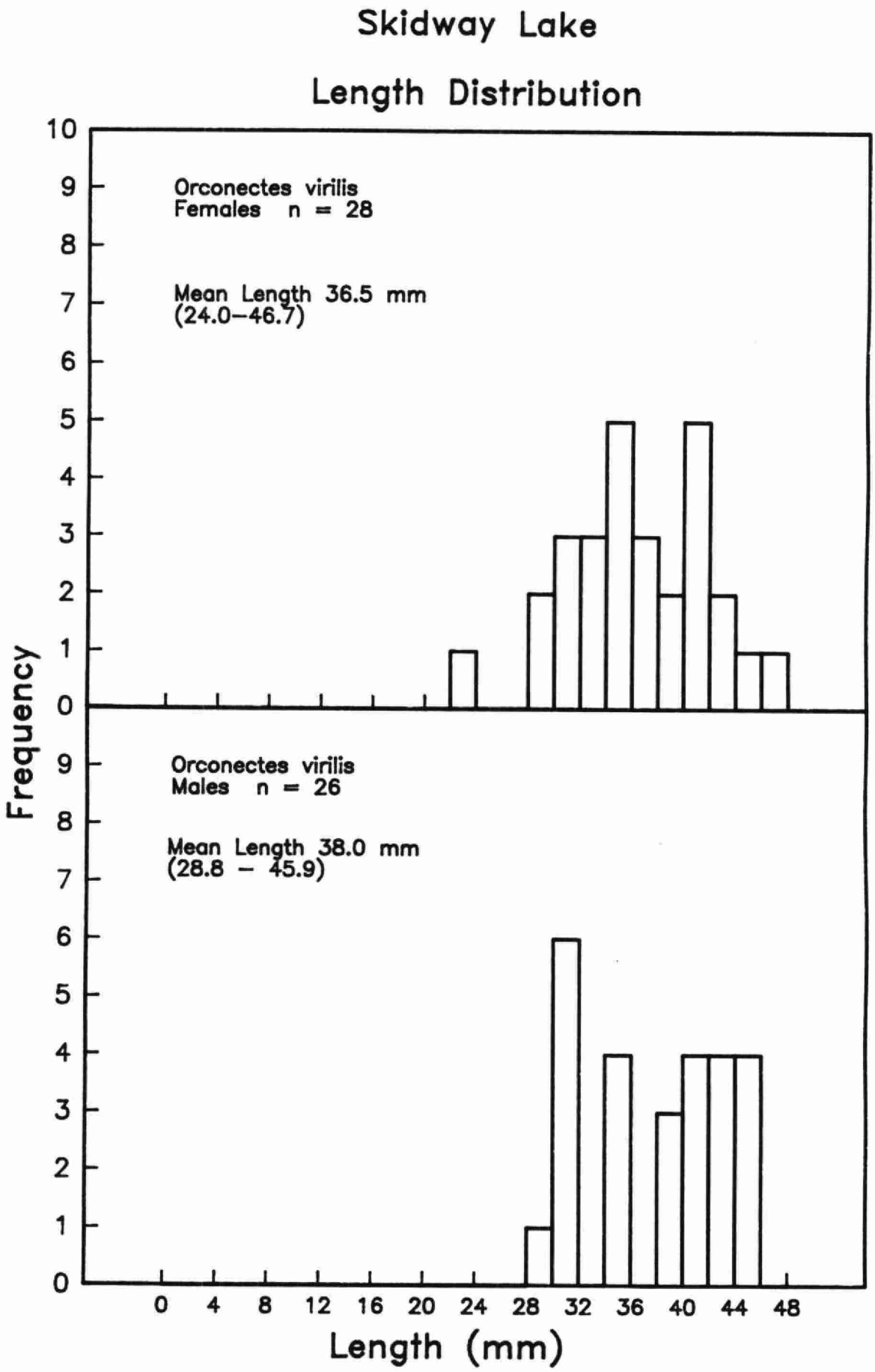
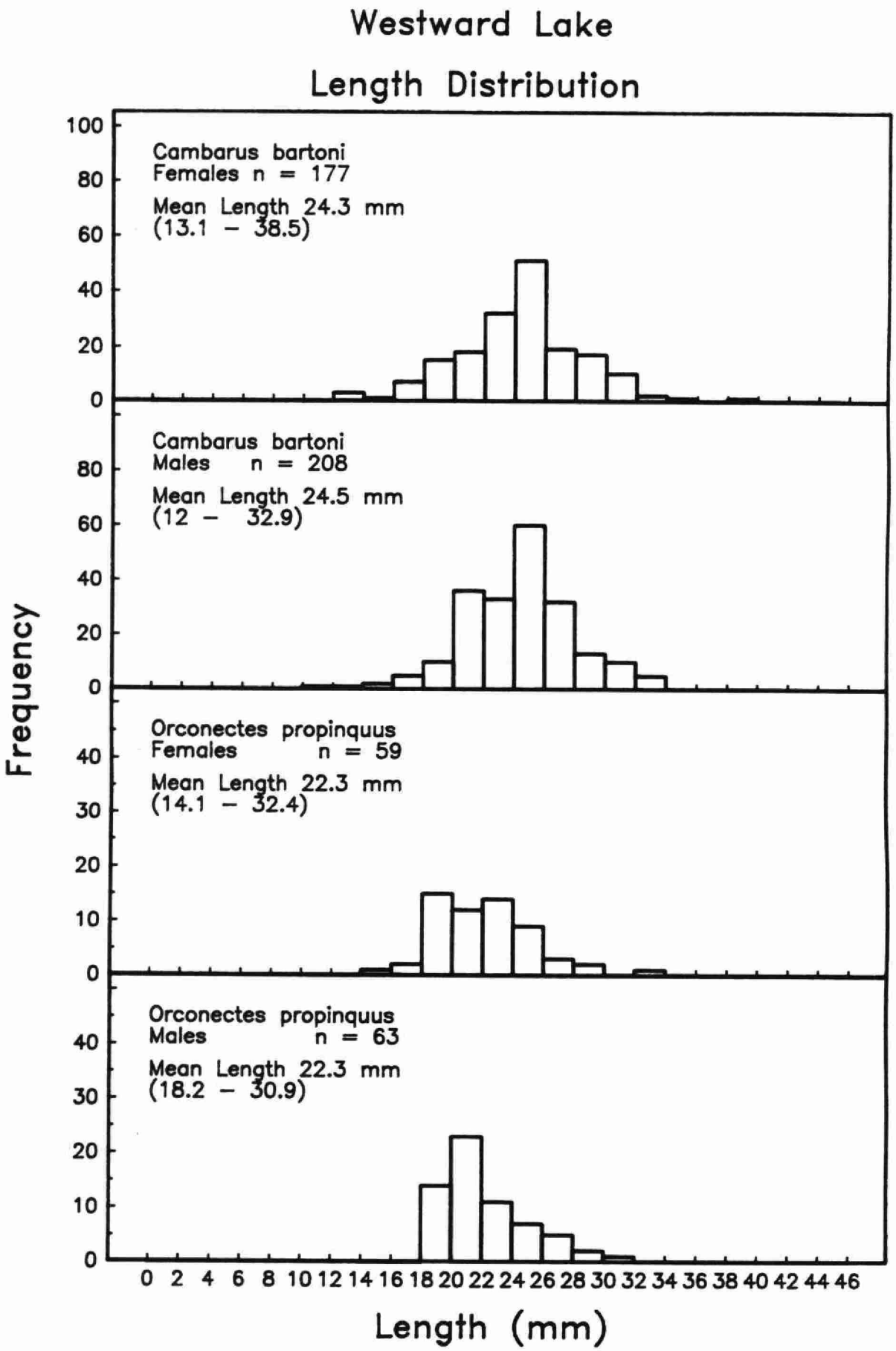
Pincher Lake

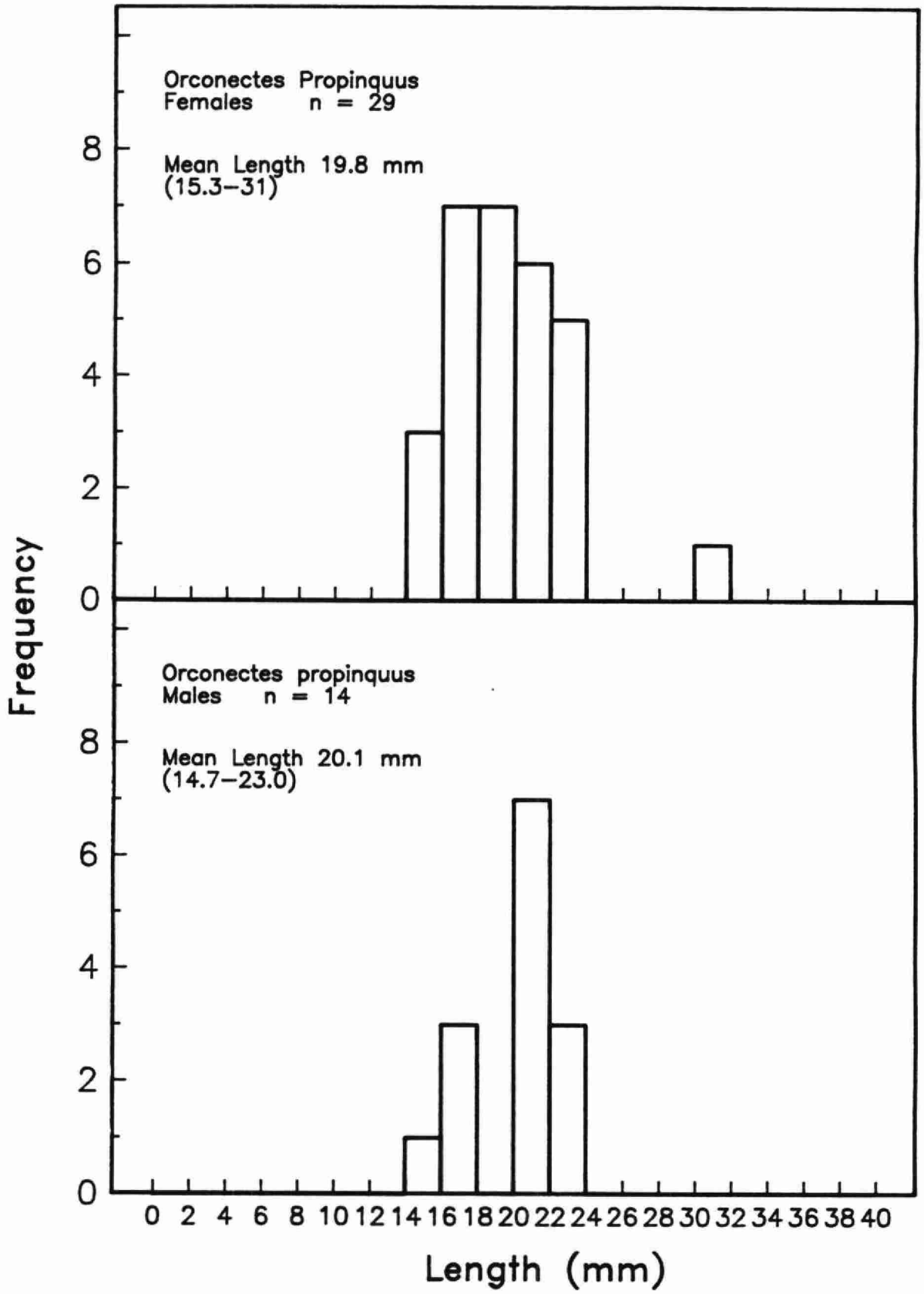
Length Distribution

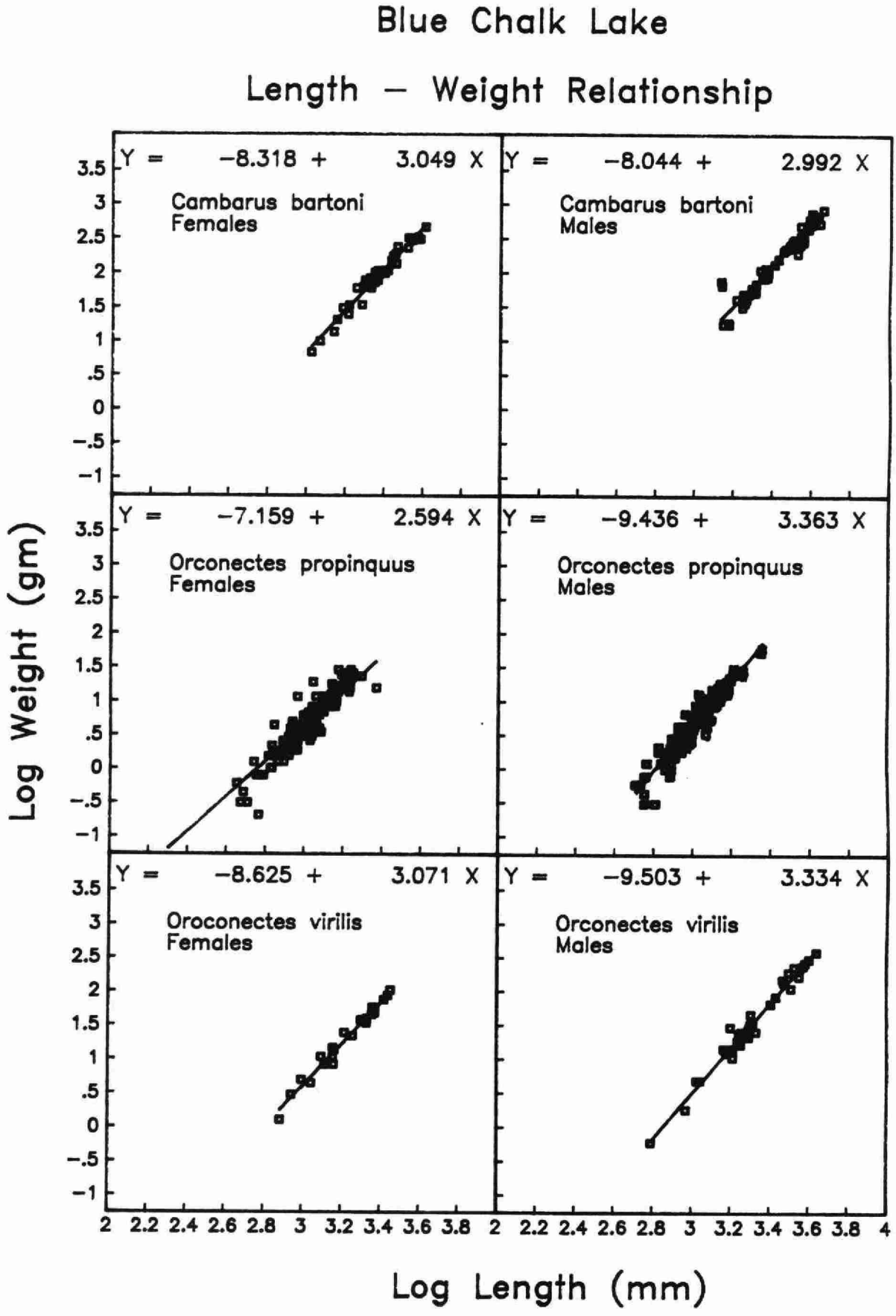



Skidway Lake
Length Distribution
Orconectes virilis
Females n = 28
Mean Length 36.5 mm
(24.0–46.7)
Orconectes virilis
Males n = 26
Mean Length 38.0 mm
(28.8 – 45.9)
Frequency
0 1 2 3 4 5 6 7 8 9 10
0 4 8 12 16 20 24 28 32 36 40 44 48
Length (mm)


Westward Lake
Length Distribution
Cambarus bartoni
Females n = 177
Mean Length 24.3 mm
(13.1 – 38.5)
Cambarus bartoni
Males n = 208
Mean Length 24.5 mm
(12 – 32.9)
Orconectes propinquus
Females n = 59
Mean Length 22.3 mm
(14.1 – 32.4)
Orconectes propinquus
Males n = 63
Mean Length 22.3 mm
(18.2 – 30.9)
Frequency
Length (mm)

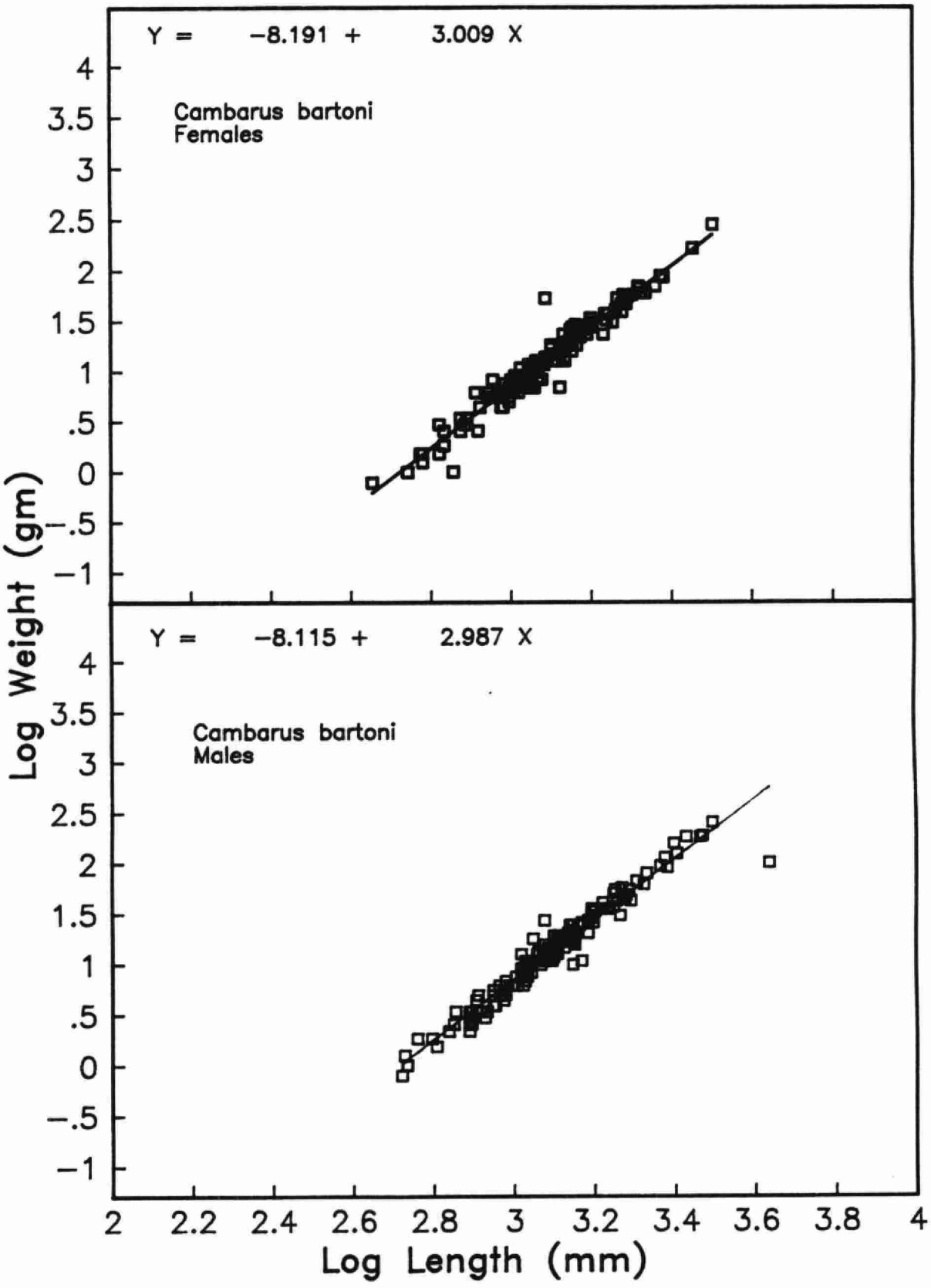
Young Lake
Length Distribution




Blue Chalk Lake
Length – Weight Relationship
Y = −8.318 + 3.049 X
Cambarus bartoni
Females
Y = −8.044 + 2.992 X
Cambarus bartoni
Males
Y = −7.159 + 2.594 X
Orconectes propinquus
Females
Y = −9.436 + 3.363 X
Orconectes propinquus
Males
Y = −8.625 + 3.071 X
Oroconectes virilis
Females
Y = −9.503 + 3.334 X
Orconectes virilis
Males
Log Weight (gm)
Log Length (mm)

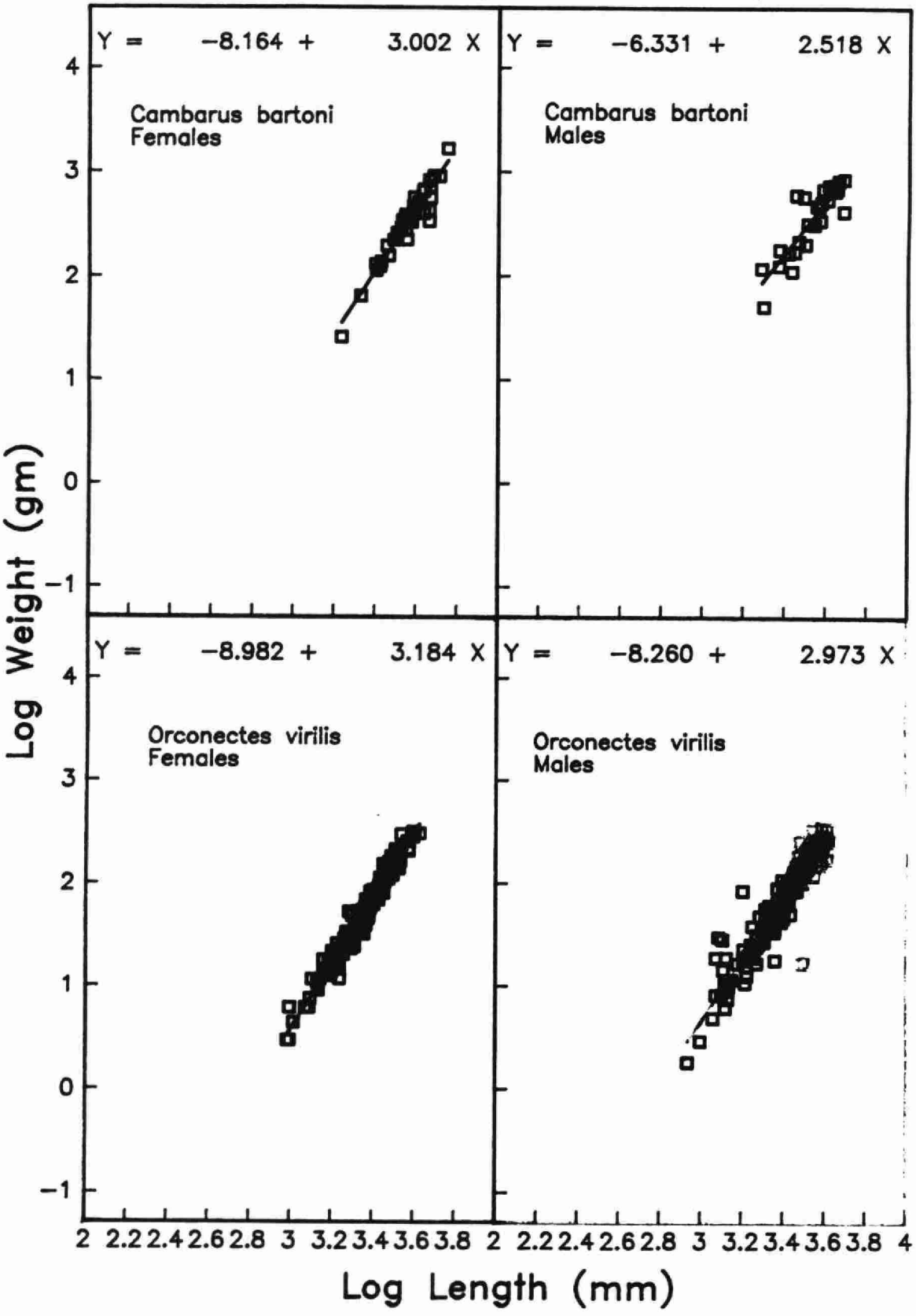
Cradle Lake

Length – Weight Relationship



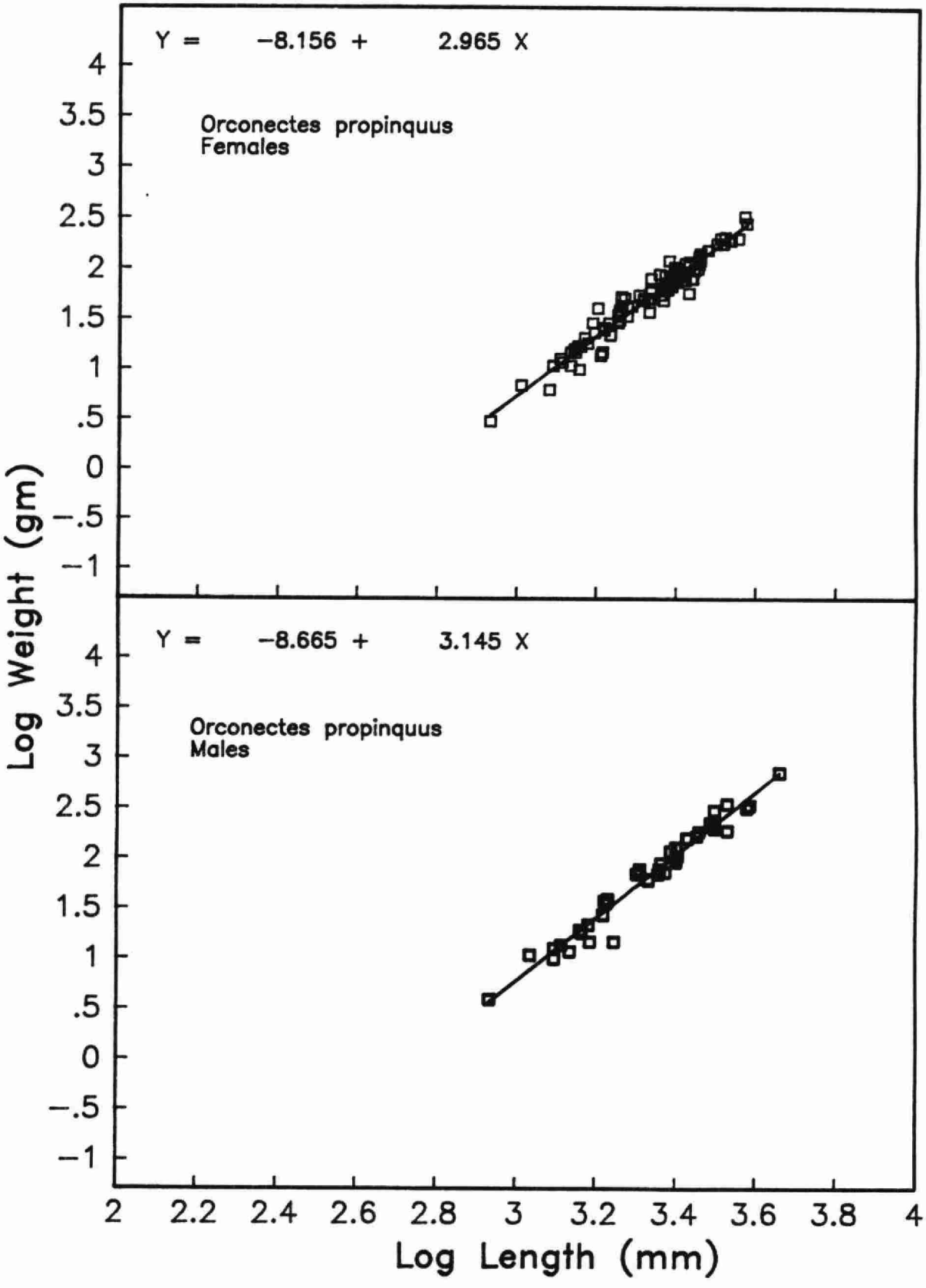
Crosson Lake

Length – Weight Relationship



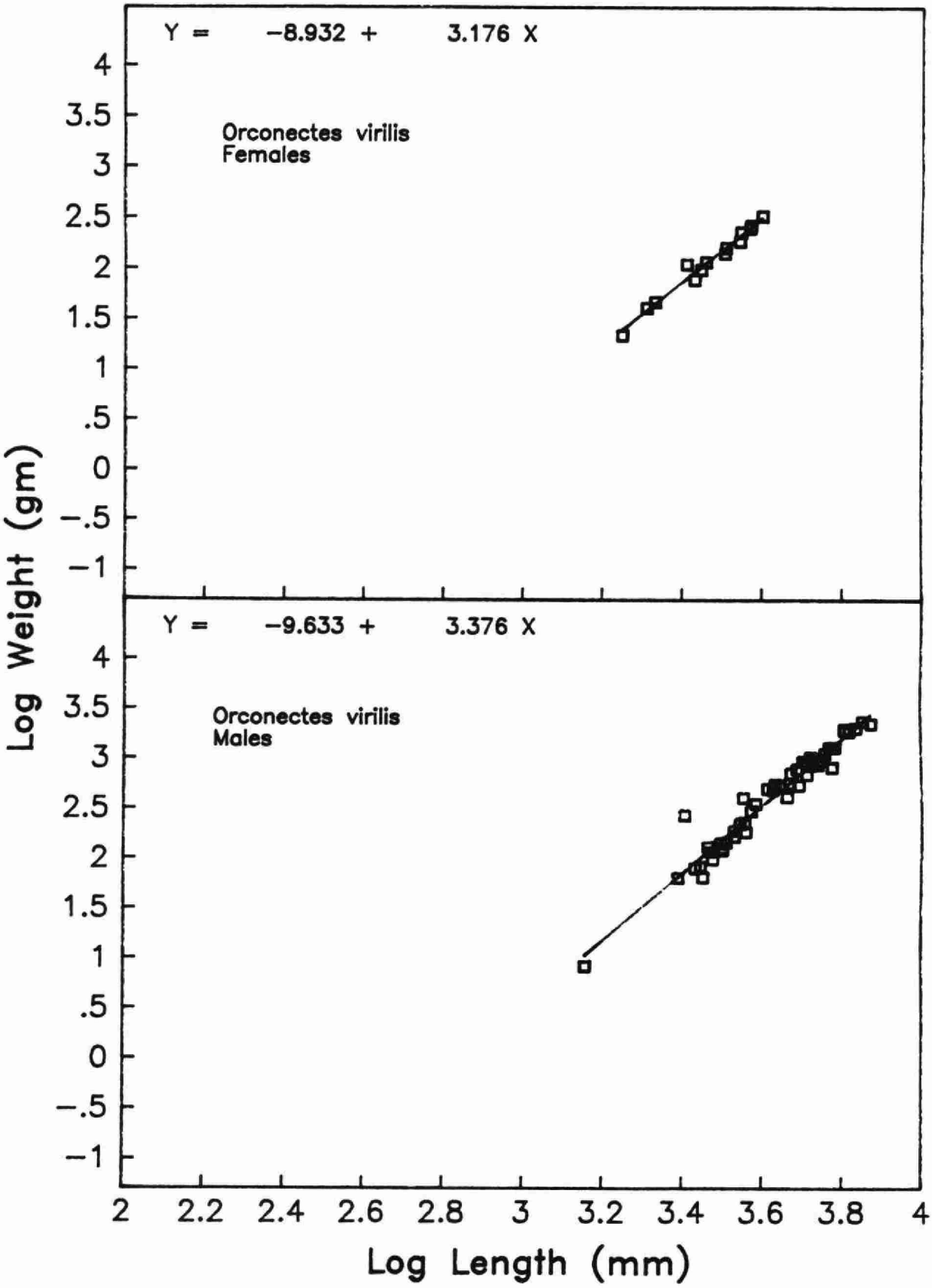
Delano Lake

Length – Weight Relationship



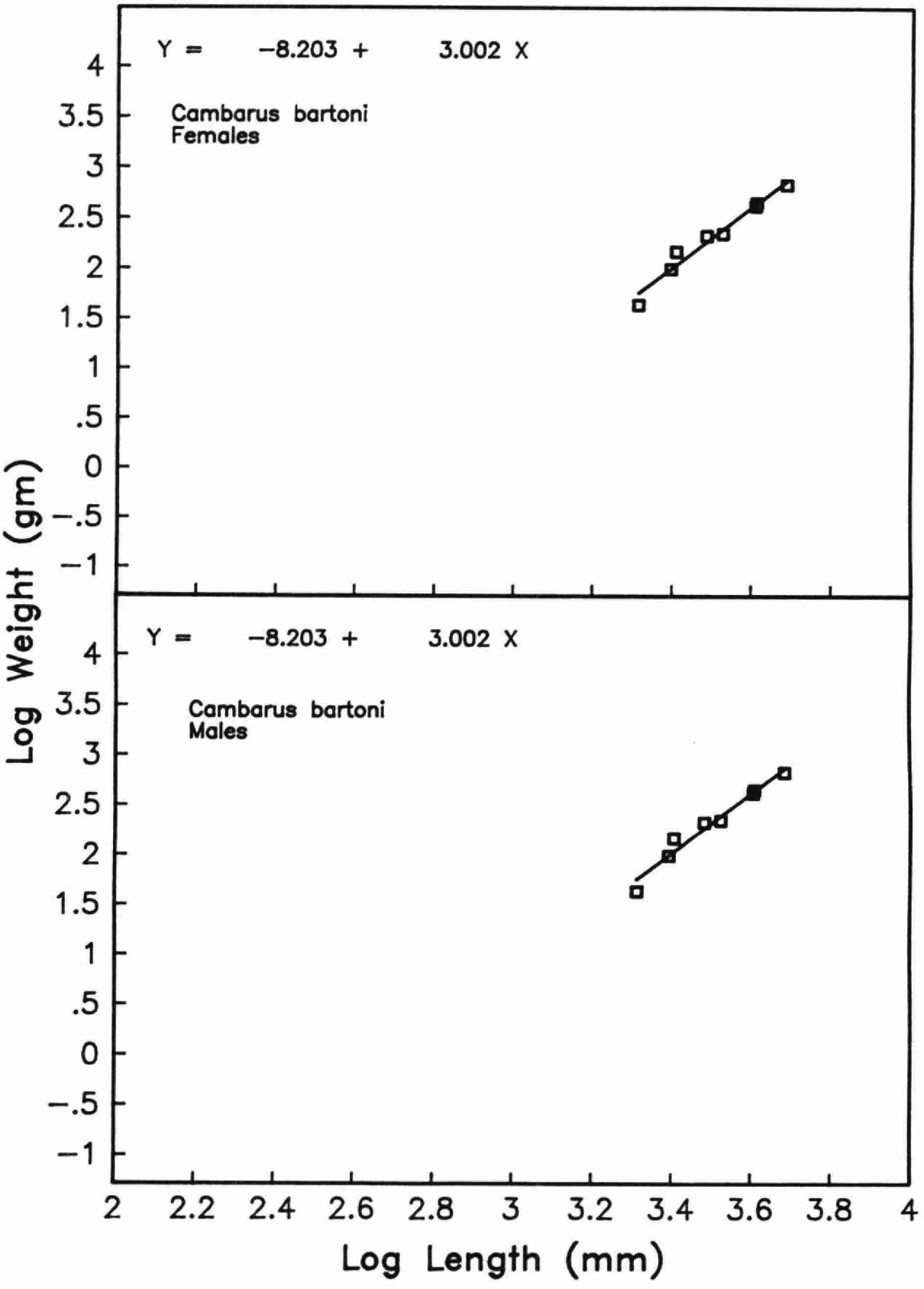
Hamer Lake

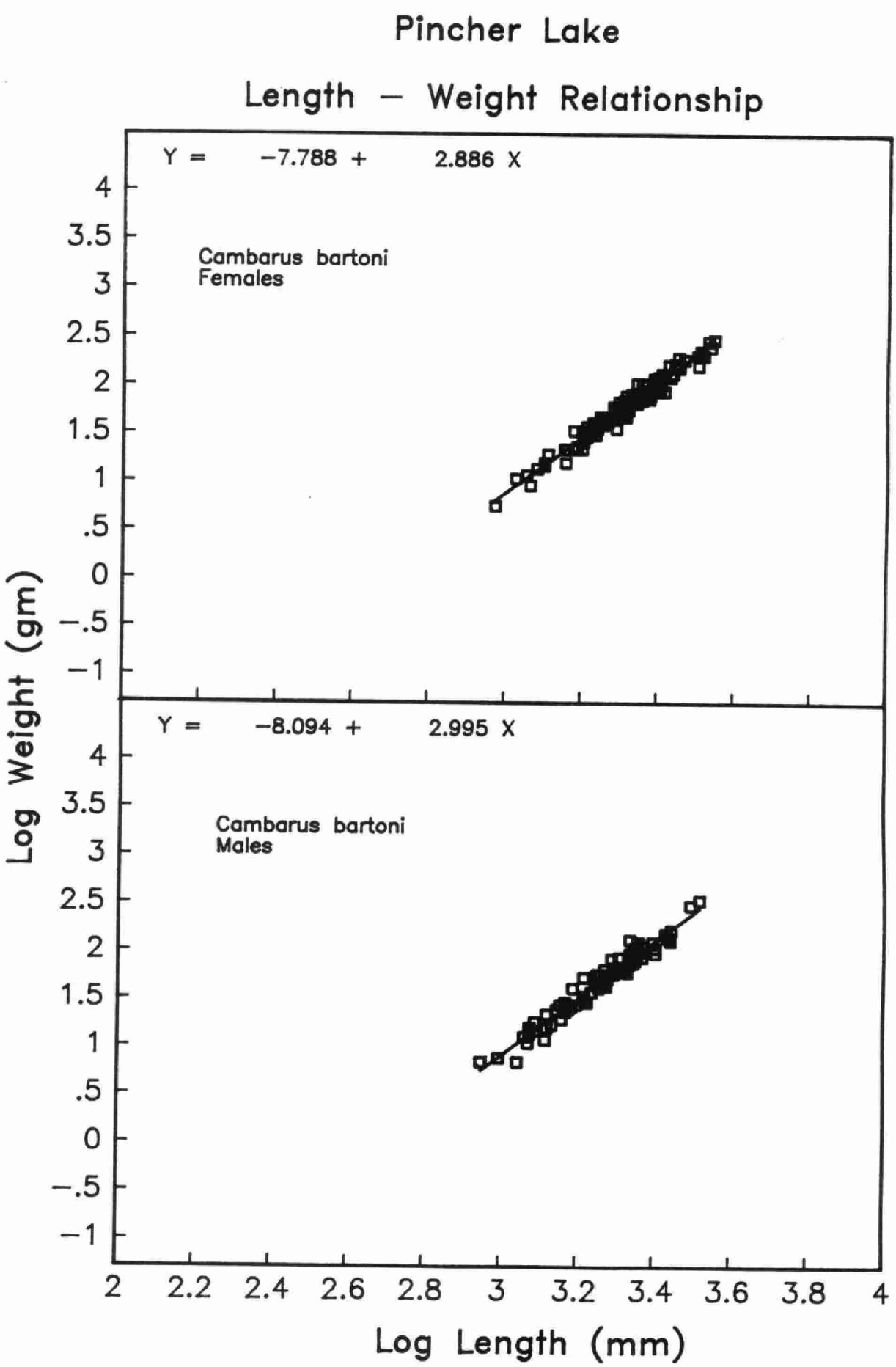
Length – Weight Relationship



Harp Lake

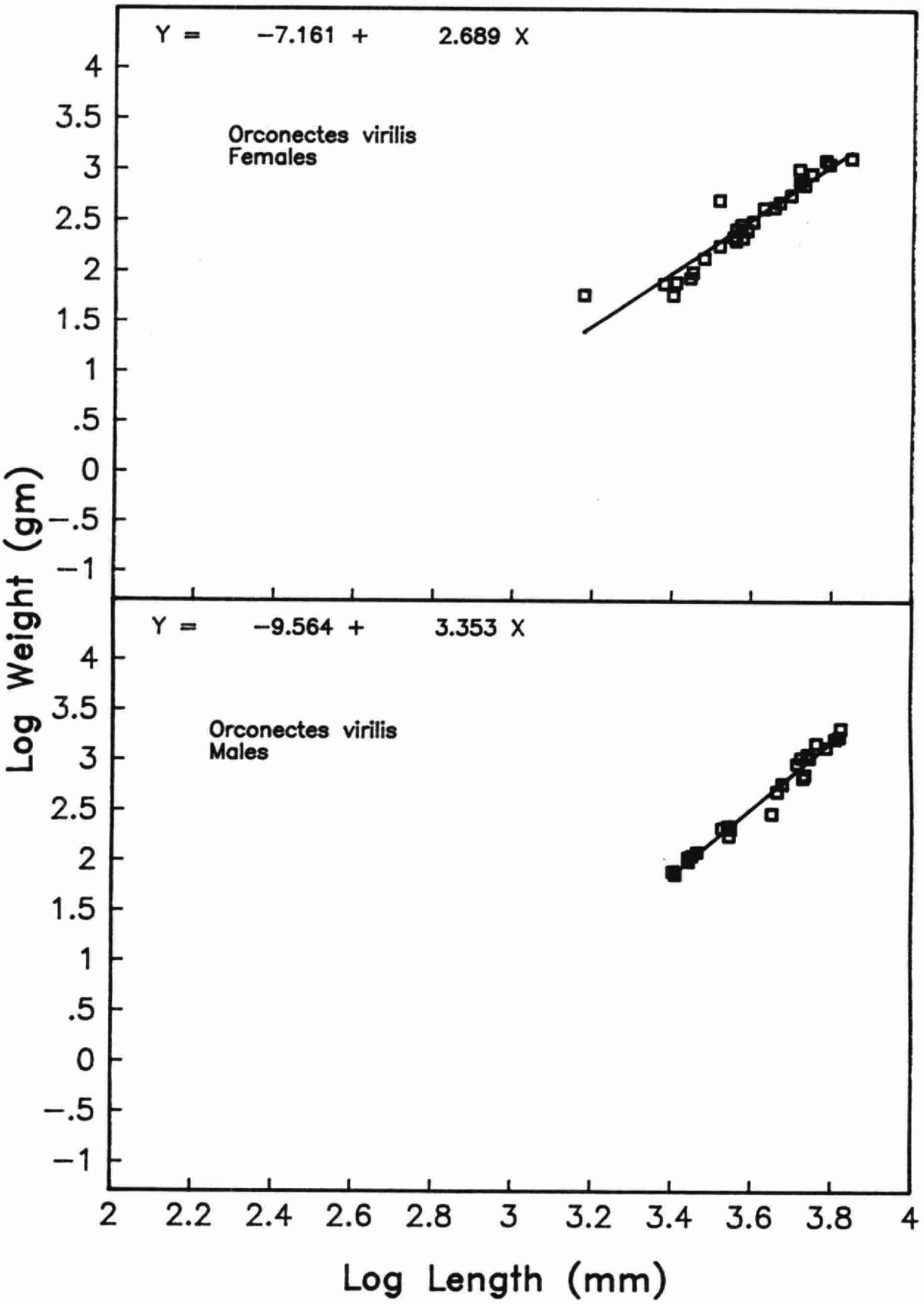
Length – Weight Relationship




Pincher Lake
Length – Weight Relationship
Y = −7.788 + 2.886 X
Cambarus bartoni
Females
Y = −8.094 + 2.995 X
Cambarus bartoni
Males
Log Weight (gm)
Log Length (mm)
4
3.5
3
2.5
2
1.5
1
.5
0
−.5
−1
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4

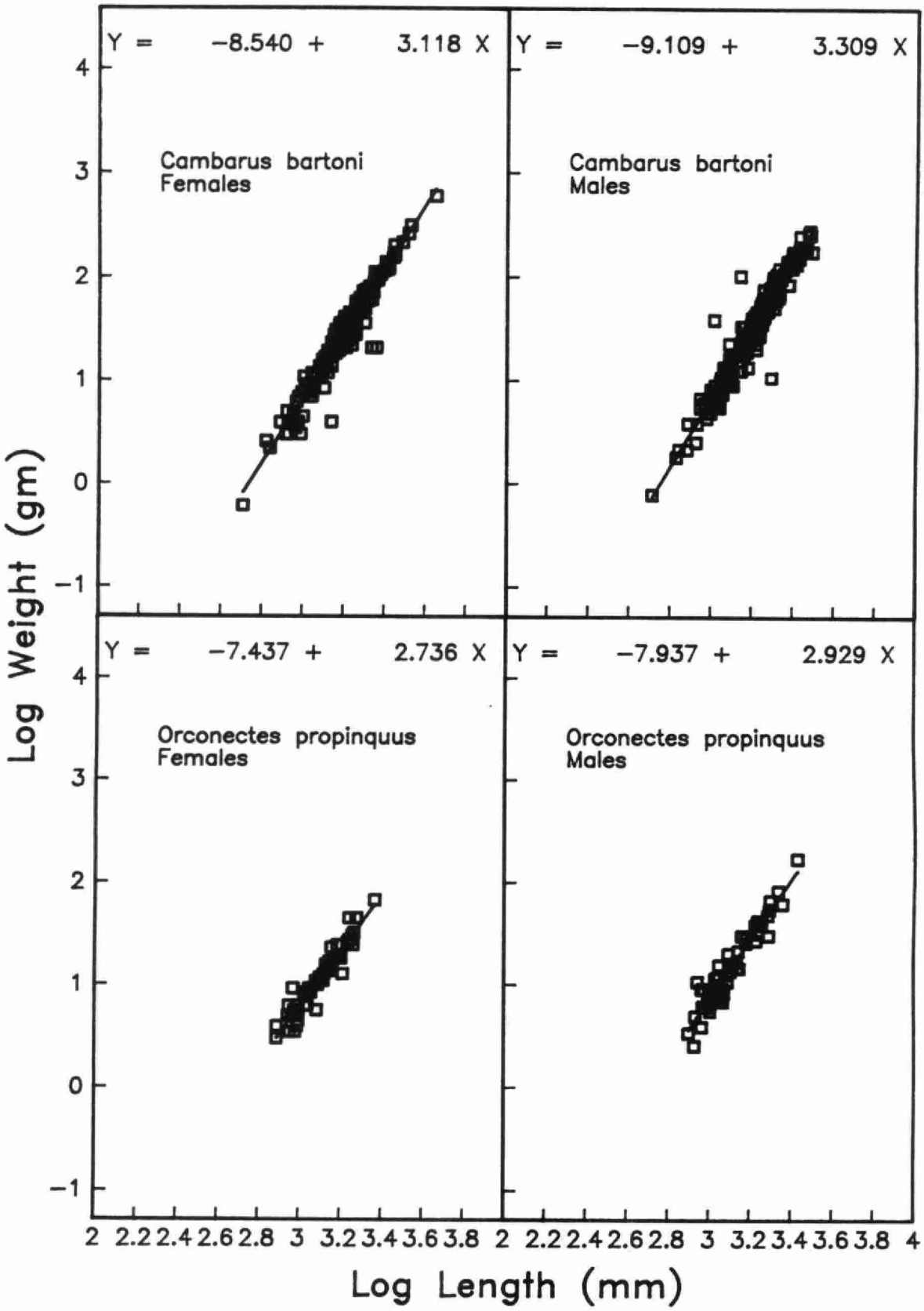
Skidway Lake

Length – Weight Relationship



Westward Lake

Length – Weight Relationship



Young Lake

Length – Weight Relationship